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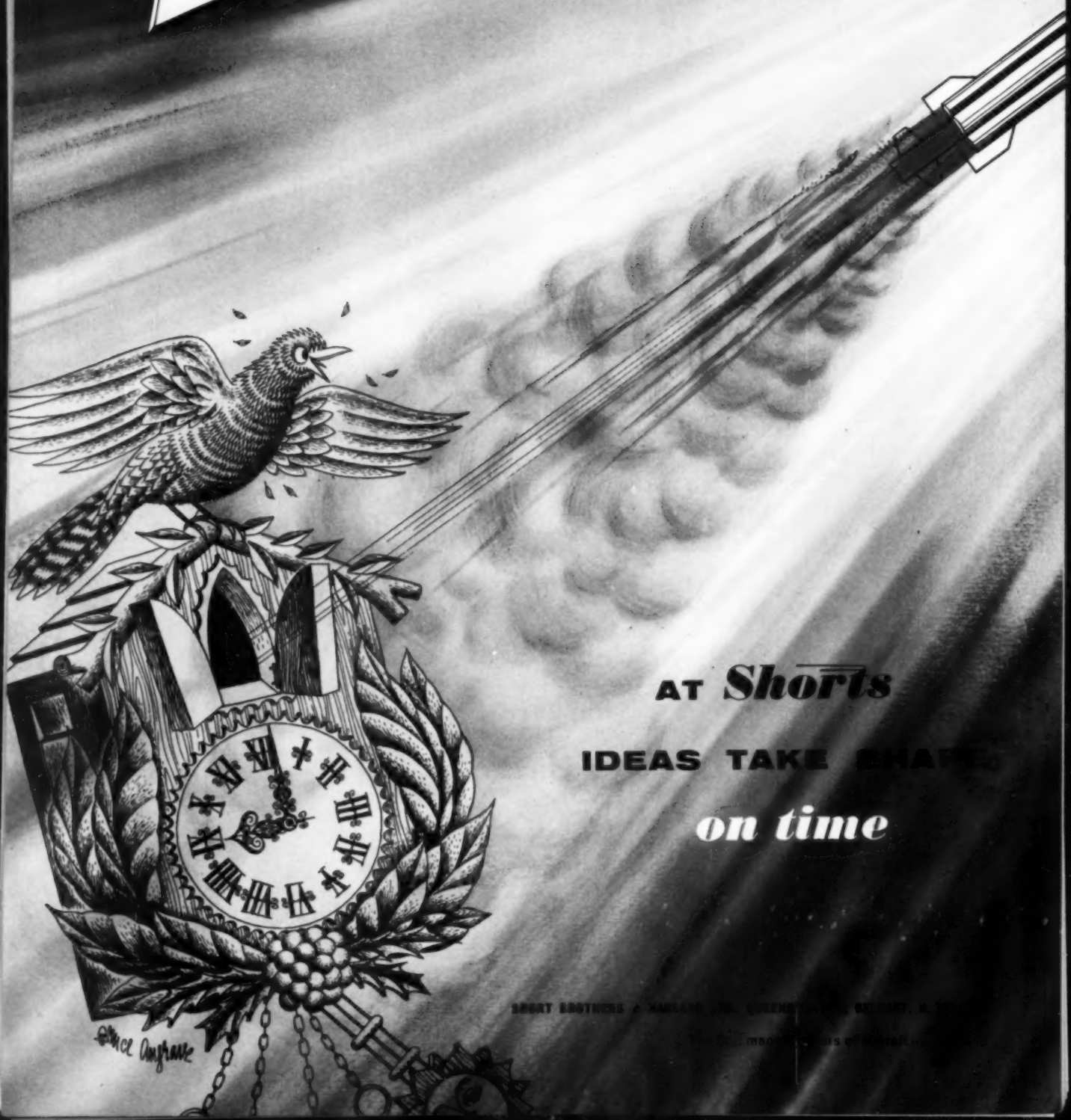

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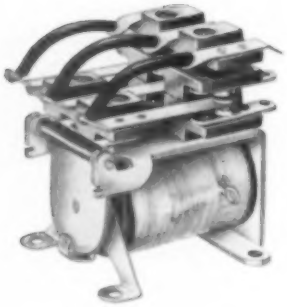

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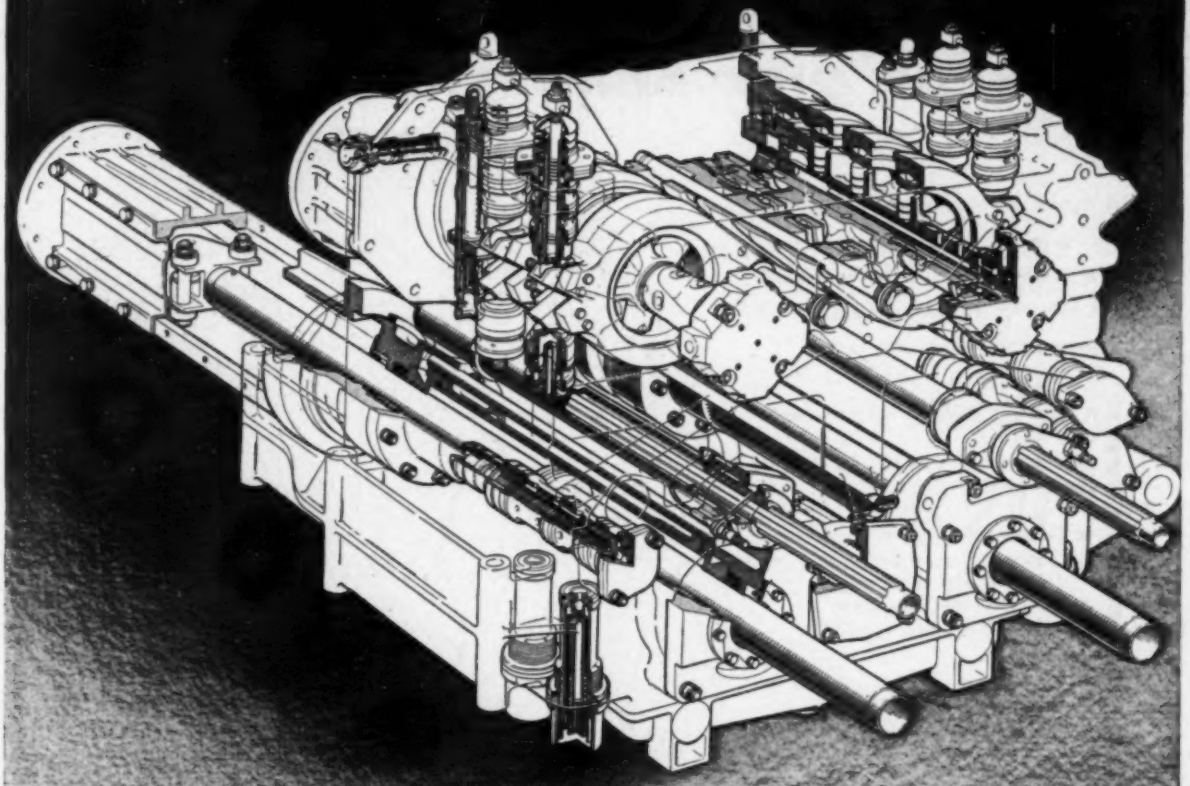

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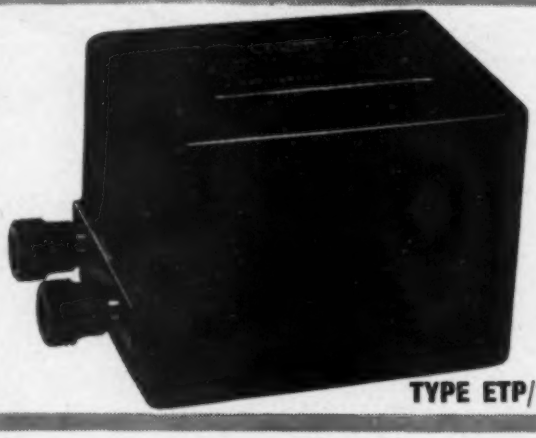

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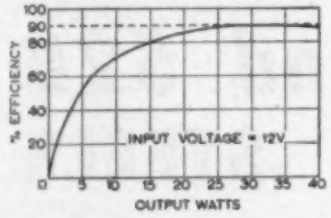
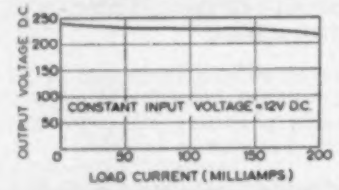
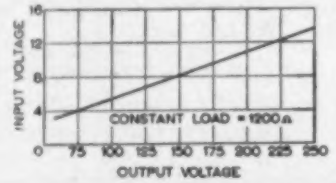


OUTPUT VOLTAGE WITH VARYING LOAD CURRENT



OUTPUT VOLTAGE AT VARYING INPUT VOLTAGE



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Hylite 30 TITANIUM ALLOY. 2% Manganese, 2% Aluminium Alloy. A relatively low alloy bridging the gap between commercially pure and the higher strength alloys.	2% Mn., 2% Al.	36.0	44.0	20.0	240
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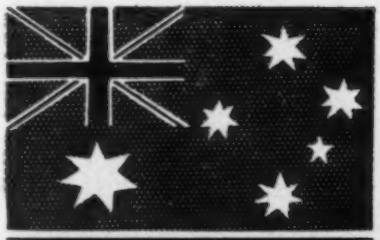
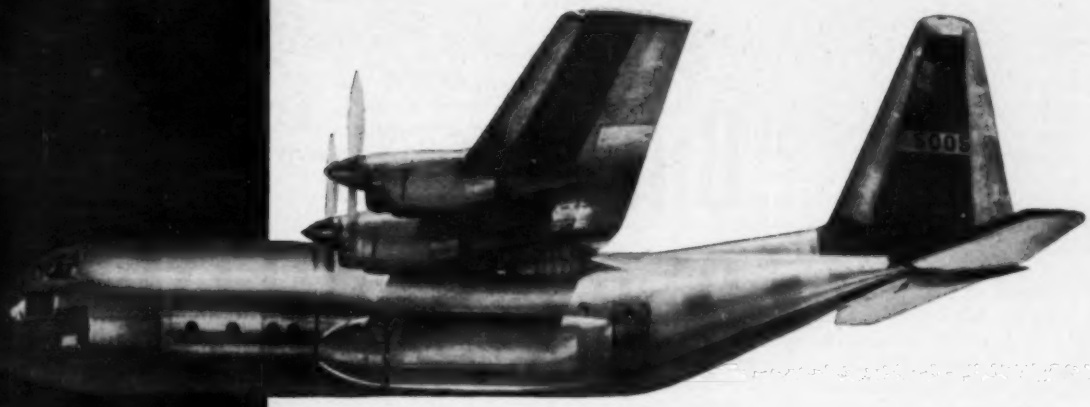


AUSTRALIA FIRST IN THE COMMONWEALTH WITH C-130 HERCULES



With the purchase of 12 Allison-powered Lockheed C-130 propjet Hercules, Australia takes her place among the leaders of the Jet Age in logistical transport. This modern Strongman of the Skies flies faster, farther, *and at less cost*, than any other military transport!

Four 3,750 h.p. T-56 Allison propjet engines with matched Aeroproducts propellers give Hercules the power to:

Transport 92 fully-equipped combat troops or 64 paratroopers at speeds up to 350 miles per hour.

Accommodate 74 stretcher patients.

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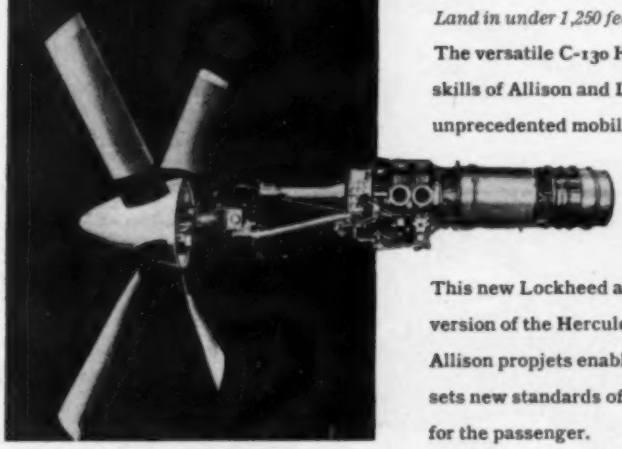
The versatile C-130 Hercules – product of the teamed engineering skills of Allison and Lockheed engineers – will provide the R.A.A.F. with unprecedented mobility and operational freedom.



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ALLISON PROP-JET POWER

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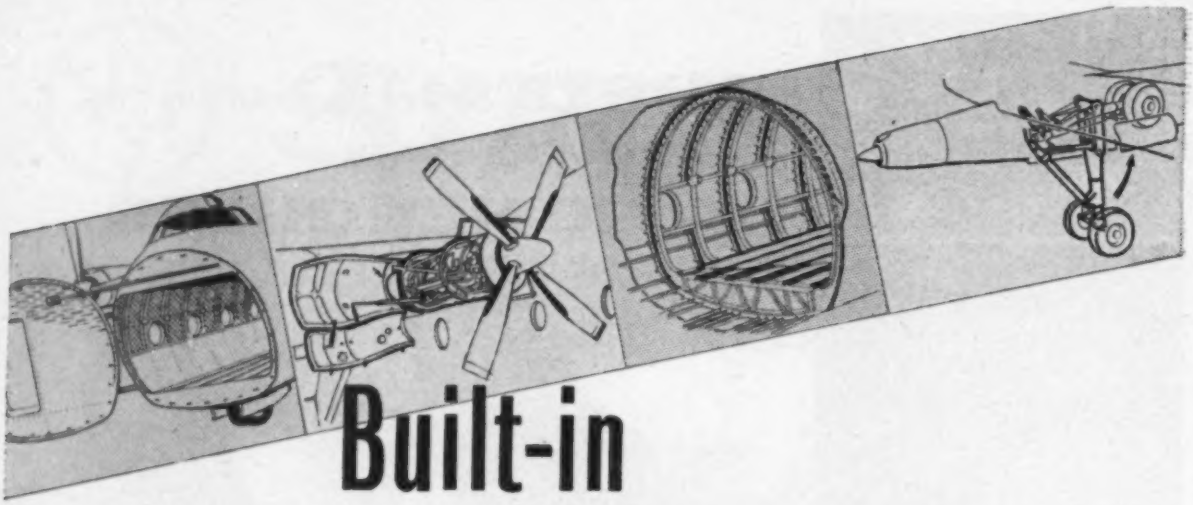

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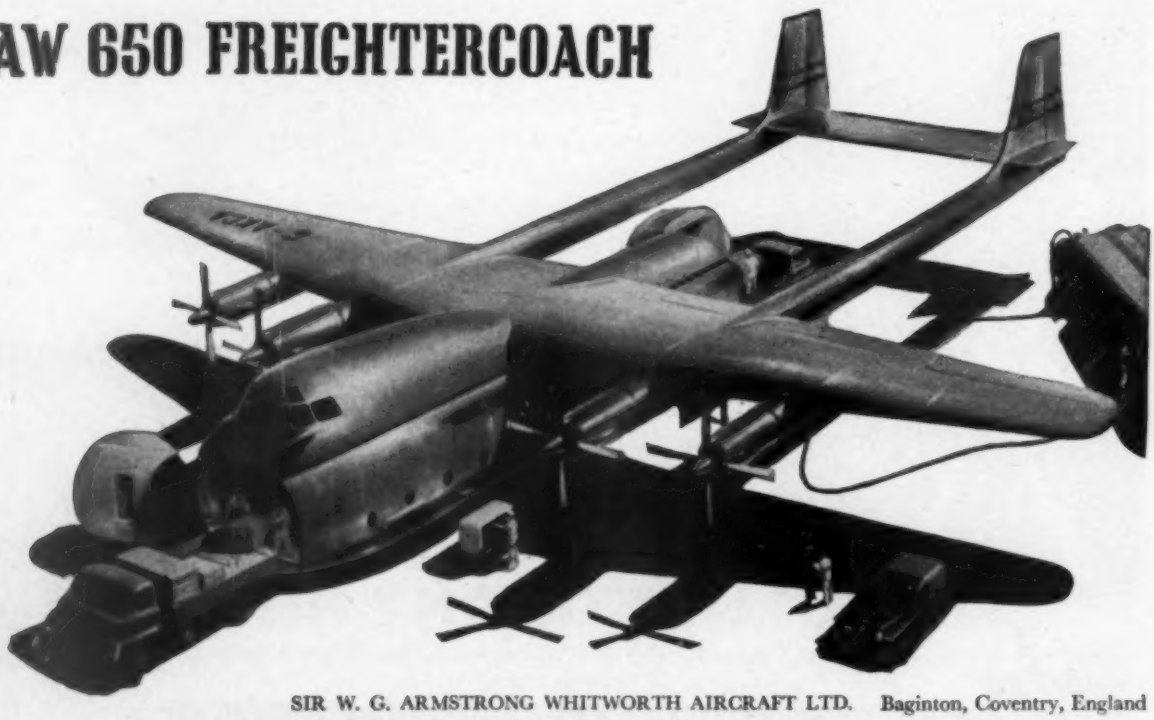
AW 650 FREIGHTERCOACH



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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

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In this issue

230 Report on Defence
232 Explorer
234 P.181 and 182
236 Towards Astronautics
239 Fighter Design Philosophy
244 From the Cameras of Coastal Command
246 Pakistan Air Force
259 The Control of Air Traffic

Interdependence and Intelligence

THE principle of interdependence in defence planning, enunciated by President Eisenhower and the Prime Minister in Washington last October and endorsed by the heads of fifteen NATO governments, will unavoidably raise, in each of the countries concerned, military, economic and political problems of varying kinds. So, at least, declares the Defence Minister in his White Paper *Report on Defence*. And the declaration is one upon which the Minister is unlikely to be challenged even by his most impassioned critics, for the White Paper itself bears evidence of a notable discrepancy between British and American military thinking.

Having remarked—reasonably enough—that Russia could not hope to knock out strategic air bases in the U.S.A. with manned bombers, the Paper goes on to assert that it would take the Russians several years to complete the development of an accurate intercontinenal rocket and to produce it in sufficient numbers.

Compare this belief with testimony by the U.S. Army, who conceded before the U.S. House Armed Services Committee (we quote *Aviation Daily*) that Russia may have a 5,000-mile ballistic missile in operation by July this year. Compare it further with an official American declaration that squadrons of Atlas ICBMs will be in service with Strategic Air Command a year after the IRBMs become operational (i.e., in December 1959). And relate this last declaration to the general post-sputnik belief that the Soviet Union has assumed the lead in IRBM development.

It may be, of course, that Britain's own assessment of the situation, as proclaimed by Mr. Sandys, is more realistic—based upon more positive, and more accurately evaluated, information. But in a world wherein peace is "being uneasily maintained by a balance of arms" (we quote the White Paper itself) a pooling of Intelligence must surely be, as in the late war, a keystone of defence planning.

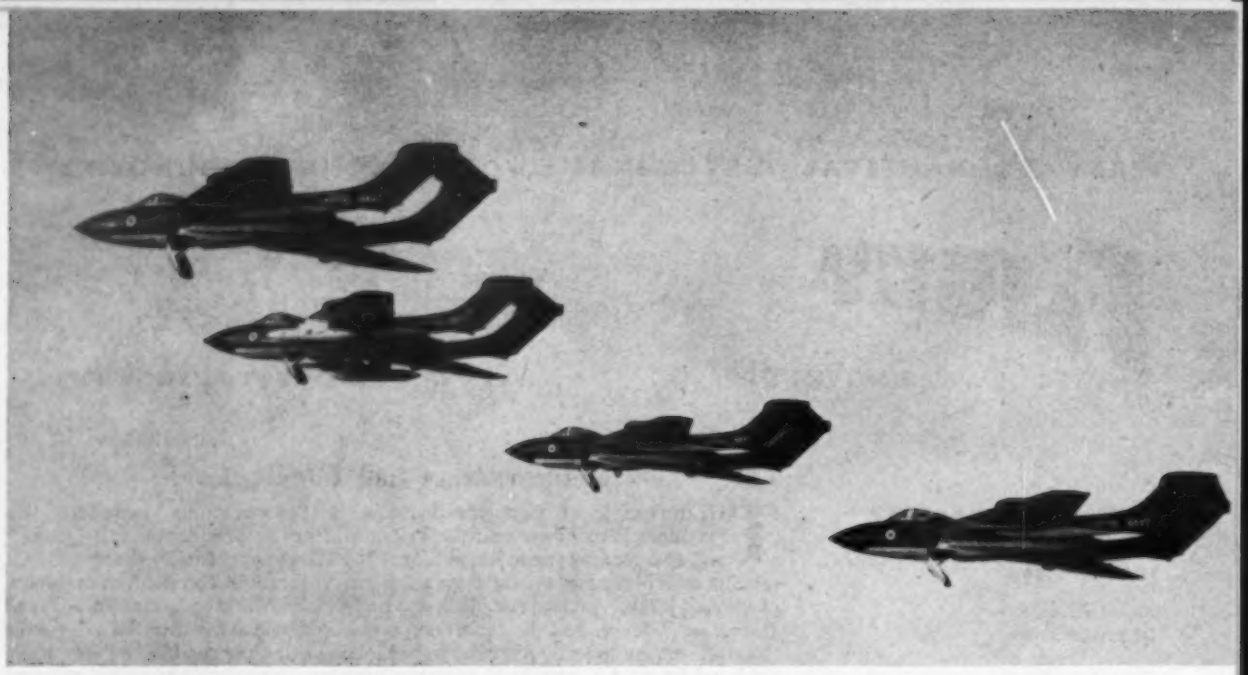
"Know your enemy" is a precept as old as warfare. But "Do not under-rate your enemy" is an equally commendable one, and one especially apt for the times.

The R.A.F.'s Next Bomber

In this same matter of Intelligence we are reminded that White Papers can usually be counted upon to provide a tit-bit or two of information not previously on public record. This year it was the disclosure by Mr. Sandys that the low-level tactical bomber being developed for the Royal Navy [the carrier-based Blackburn NA.39, with two de Havilland Gyron Junior turbojets] is being considered for adoption by the Royal Air Force also.

It had been widely conjectured, of course, that a compact aeroplane of this class, of relatively low all-up weight, having an exceptional speed range and with atomic capability, should prove of interest to the R.A.F., especially for overseas operations. Indeed, Mr. Eric Turner, chairman of Blackburn and General Aircraft, had expressed his view that it seemed suitable for the R.A.F., NATO and the Commonwealth "as either a land or ship-based bomber." But it was also widely supposed that there was a definite R.A.F. requirement for a supersonic low-level bomber (nowhere has it been officially stated that the NA.39 is, itself, supersonic) suitable for operation over longer ranges and having extremely advanced navigational aids. This, it was thought, was the aeroplane in Sir Matthew Slattery's mind when he alluded, at a recent Air League conference, to a type now in prospect which is so complicated that no single team in the British aircraft industry would be capable of handling it.

Whether or not Mr. Chapman Pincher of the *Daily Express* is right in asserting that "air chiefs" argue that the range of the NA.39 is so short that there are no worthwhile targets for it, and insist that it is useless for their purposes, remains to be seen. It is, however, tolerably clear that an R.A.F. requirement has been stated for an aircraft in a different performance bracket from that of the NA.39, and a persistent Air Staff demand for such an advanced bomber could well erupt into public notice in the months ahead.



NAVAL LADIES: de Havilland Sea Vixen FAW.21 all-weather carrier-borne fighters for the Royal Navy, built at Christchurch and flown by Mr. J. Elliot (chief test pilot at Christchurch), Lt-Cdr. P. Barlow, R.N., Mr. A. C. Capper and Mr. R. E. Clear. One aircraft is carrying D.H. Firestreak infra-red homing missiles, four of which will be standard armament for Sea Vixens in service with the Fleet Air Arm.

FROM ALL QUARTERS

Supply Minister on B.E.A.'s Jet

IN a statement in the House of Commons last Monday, the Minister of Supply, Mr. Aubrey Jones, summed up the objectives of his approach to the problem of B.E.A.'s jet order. Firstly, he wished to ensure that the project would not involve financial liabilities on his department, partly because such liabilities had been heavy in the past, and partly because it was "healthier for the industry" to be more self-reliant. De Havilland's first proposal required a Government financial contribution. Their proposal of December 19 promised private financing among the other contractors, with reservations about the volume of other Ministry contracts. The further proposals of January 23 would have to be carefully examined "to make sure my department is protected against contingent liabilities." He was also anxious to ensure that the arrangements would be calculated to "align home demand with potential foreign demand."

Canadair CL-66 Cosmopolitan

ON February 12 the Canadian Defence Department in Ottawa announced an order for ten Cosmopolitan aircraft from Canadair, Ltd., of Montreal; they will be operated by Transport Command of the R.C.A.F.

The CL-66 Cosmopolitan is an improved Convair 440 Metropolitan powered by a pair of Napier Eland turboprops. Canadair and Convair are both subsidiaries of the General Dynamics Corporation of New York. Convair have been investigating the possibility of going into production with an Eland-powered CV-440 for two years, but did not succeed in selling the aircraft. The last CV-440 is almost completed at Plant 1, San Diego, and the floor space previously devoted to the manufacture of this aircraft has already been cleared for occupation by the CV-880 final assembly department. Practically all the CV-440 jigging is being sent by rail to Montreal, together with a considerable quantity of spares and components to assist Canadair in producing the Cosmopolitan.

Canadair will handle the complete manufacture of the new transport, which will be built in parallel with the CL-28 Argus and the CL-44 long-range transport. It is not yet known to what extent the airframe will differ from that of the CV-440, but development should be rapid and the first delivery is due in one year's time. Canadair have placed an order worth between $4m and $5m for the Eland engines, which will be manufactured at Napier's works at Netherton, Liverpool. It will be remembered that an Eland-powered CV-340 is at present undergoing certification trials at Santa Monica, and Napier have also purchased a CV-440 to replace the former aircraft as the company's standard development and demonstration machine. Canadair doubtless expect to make considerably more than ten Cosmopolitans; meanwhile Napier are continuing to promote the Eland as a replacement powerplant for piston-engined airliners and have already achieved one firm sale (to R.E.A.L. of Brazil) and a considerable number of interested customers, including Panair do Brazil for L-49 Constellations.

Antarctic Air-Drops Ended

AS tidal pressures in the Ross Sea have now made the 6,000ft ice runway at McMurdo Sound unusable, American plans to air-supply their bases in Antarctica by Globemasters have had to be abandoned until next season. The last Globemaster to land at McMurdo took off from there at short notice in the early hours of last Sunday morning, after helicopter reconnaissance flights had observed widening cracks in the ice up to within 1,000 yd of the landing strip. Other American aircraft are now using Scott Base, where there are two Dakotas, two Otters, a Beaver (pictured on the facing page) and an Auster—belonging variously to Britain, New Zealand and the U.S.

Navaids Checked at 40,000 ft

IN addition to DC-3s, Twin Beeches and Convair 440s, America's Civil Aeronautics Administration is now using two converted Martin B-57s (English Electric Canberra licence) to test both

NAVAL GENTLEMEN: Seen with a D.H. Sea Vixen in which the First Lord later flew are (l. to r.) Mr. P. E. C. Moore, Principal Private Secretary; Mr. J. Elliot; the Earl of Selkirk, First Lord of the Admiralty; Rear Admiral R. A. Ewing, Naval Secretary; Mr. W. A. Tamblin, chief designer at D.H. Christchurch; and Mr. A. F. Burke, managing director of the de Havilland Aircraft Co.

DEPOT 700 is the destination of this de Havilland Canada Beaver which has been used by Sir Edmund Hillary and which, when it was photographed over Minna Bluff, was carrying supplies.

experimental and standard electronic navigation aids on U.S. airways. Some 400 civil-airway facilities have to be checked every 120 days.

The B-57s are being used at heights around 40,000ft to assess the effectiveness and accuracy of the standard aids for use by the big jets. Each B-57 carries duplicated V.O.R. and Tacan, I.L.S., glide-slope and marker beacon receivers and full communications equipment—all by Collins Radio. Ground-position fixes accurate to within ±500ft are being obtained using two D.M.E. stations located about 90 miles apart. All Vortac ground stations are now also being surveyed on the ground to determine their exact position in latitude and longitude. V.O.R. and Tacan signals received in the B-57s are analysed and recorded on oscilloscopes; and position fixes are taken and calculated to an accuracy of one-hundredth of a degree in azimuth and one-hundredth of a mile. The main object of the B-57 programme is to find out whether present ground aids are going to be suitable for jet airliners at high altitudes and, if not, what modifications should be applied.

One of the first test programmes was made in conjunction with the Vortac station at Phillipsburg, Pennsylvania. The B-57s are reported to have obtained geographical fixes at 40,000ft accurate to within ±500ft.

Flight Recorders for Jet Transports

IN accordance with a C.A.A. requirement, all large transport aircraft flying above 25,000ft after July 15 this year will have to carry a flight recorder. Equipment of this type is to be manufactured and sold by Lockheed Aircraft Service, Inc., under licence from the mechanical division of General Mills, Inc. Aircraft such as the Lockheed Jetstar, Convair 880, Caravelle, DC-8 and Boeing 707 and 720 series will be so fitted.

The recorder registers I.A.S., altitude, g, compass heading and time on an aluminium-foil tape. Housed in a shock-resistant spherical shell of 14in diameter, it weighs 28.5 lb. Reels of 100ft of tape are moved through the recorder heads at six inches per hour by a motor geared to a clock escapement or governor. A spring further provides enough energy to run the recorder for ten minutes after power failure. The tape, it is claimed, can withstand 100g shock, 2,000 deg F temperature for 30 min, and immersion in sea water for 36 hr.

P.1 and Scimitar Simulators

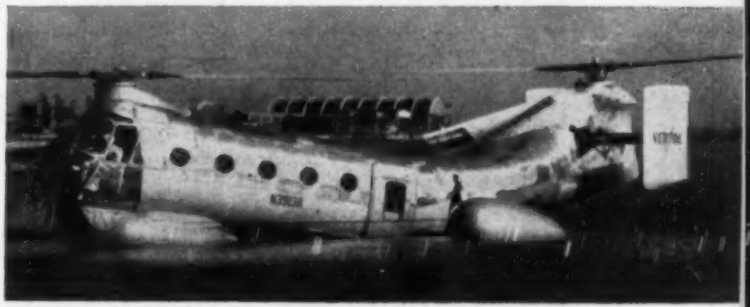
FLIGHT simulators for both the English Electric P.1 and the Vickers-Supermarine Scimitar are being built at Aylesbury by Air Trainers (Link), Ltd. Extensive use is being made of D.C. computation, a technique which was originated by this company about eight years ago. A Vulcan simulator has already been built and delivered to the Vulcan O.C.U. at Waddington and others are nearing completion. A Hunter installation is in service at Chivenor. Civil simulators already completed include those for the Elizabethan, Viscount 701 and 802, while one for the Vanguard, with moving base, is being designed.

The principle of the moving base, which became widely familiar in the traditional Link trainers, is fast regaining popularity because of the added realism of physical sensation which can be provided. Air Trainers are constructing Britannia-type trainers with moving bases; and similar machines for the Viscount have been ordered by T.C.A. and Capital. A number of attempts have been made to provide external visual references for simulators; and the company is working on such devices also.

BIG RIVER: Most powerful member of the Rolls-Royce "River" class of gas-turbine aero engines is the Conway by-pass turbojet. This photograph shows an RCo.11, of the type now in production for the Handley Page Victor B.2, on a test-bed at Sinfin, Derby. The RCo.11 has completed a type-test at a declared initial rating of 17,250 lb at the lowest specific fuel consumption yet recorded by any turbojet.

MIG-17s of the Soviet Air Force (left) are seen in this recently received photograph. They are carrying auxiliary under-wing tanks.

HELIBOAT: Below, a Vertol 44 afloat on the Delaware River at Philadelphia, where it has been testing a combination of sealed fuselage and floats—to be supplied to civilian over-water operators.



Report on Defence

"Britain's Contribution to Peace and Security"

THE above title and subtitle headed the Government's White Paper on Defence, published on February 13. The following extracts are of particular significance, and editorial comment appears on page 227.

Balance of Arms

Russia's successful launching of artificial satellites is evidence of her remarkable progress in rocket development. But it should not be thought that this has upset the balance of military power. In fact, the overall superiority of the West is likely to increase rather than diminish, as a consequence of the advent of medium-range ballistic rockets. These weapons, against which there is at present no answer, could, from sites in Europe and elsewhere, dominate practically every target of importance in the Soviet Union. The possession by Russia of rockets of equal range will not, for reasons of geography, afford her any corresponding strategic advantage. It would be of no use to her to attack Western Europe unless she could simultaneously knock out the vital strategic air bases in the United States. She could at present have no reasonable hope of achieving this with manned bombers, and it will still take her several years to complete the development of an accurate inter-continental rocket and produce it in sufficient numbers. Even then, there could be no certainty of the success of an attack. Moreover, by that time the United States, which has now also successfully launched an artificial satellite, will have inter-continental rockets also; and strategic rocket weapons of all ranges will, in due course, be made relatively invulnerable by siting underground. Meanwhile, both sides are proceeding with the development of submarines, capable of firing nuclear missiles from under water.

Disarmament

Russia has been making great strides in the field of nuclear weapons and rockets. But her basic strength lies in her overwhelming superiority in conventional armaments and military manpower. The Soviet Union and her satellites have over 200 active divisions facing the West, about 20,000 aircraft, and a fleet which includes some 500 submarines. The West, on the other hand, relies for its defence primarily upon the deterrent effect of its vast stockpile of nuclear weapons and its capacity to deliver them. The democratic Western nations will never start a war against Russia. But it must be well understood that, if Russia were to launch a major attack on them, even with conventional forces only, they would have to hit back with strategic nuclear weapons. In fact, the strategy of NATO is based on the frank recognition that a full-scale Soviet attack could not be repelled without resort to a massive nuclear bombardment of the sources of power in Russia. In that event, the role of the allied defence forces in Europe would be to hold the front for the time needed to allow the effects of the nuclear counter-offensive to make themselves felt.

Nuclear Deterrent

It is of the highest importance that the frontiers of the free world should be resolutely defended on the ground; and it must be made clear beyond all doubt that aggression will be resisted. The three regional defence organizations together provide this vitally necessary defensive shield. But the effectiveness of the shield depends ultimately on the fact that behind it stands the immense nuclear power of the West, which is part and parcel of the allied defence system. This continues to rest primarily upon the strength and constant readiness of the American Strategic Air Command, with its bases all round the world and its vast supply of megaton bombs. However, Britain is now making an increasingly significant contribution to the Western nuclear deterrent. She has a substantial and growing stockpile of kiloton weapons, the design of which is being steadily improved, as a result of the experience gained from the trials at the Maralinga proving ground in Australia. Following upon the successful thermo-nuclear tests at Christmas Island, British megaton bombs are now in production and deliveries to the Royal Air Force have begun.

The British strategic bomber force, which is equipped to carry these bombs, provides a mobile and flexible form of military power. While based in Britain, its aircraft can be transferred within a few hours to stations overseas. The majority of the squadrons are equipped with Valiants; but the proportion of Vulcans and Victors, with their greater performance, is increasing. These can fly as high and as fast as any bombers in service in any other country; and their navigational and bomb-aiming equipment is of the highest accuracy. In addition, progress is being made with the development of propelled bombs, which can be released from a considerable distance, thereby making it unnecessary for the aircraft to fly into the more heavily defended target area.

Britain's nuclear power cannot, of course, be compared in magnitude with that of the United States. Nevertheless, when fully equipped with megaton weapons, the British bomber force will in itself constitute a formidable deterrent. If the deterrent influence of the bomber force is to be effective, it must not be thought capable of being knocked out on the ground. Measures are accordingly being taken to raise its state of readiness, so as to reduce to the minimum the time needed for take-off. Other action is also being taken to increase the security of the bomber force. In order to obtain the earliest possible warning of the approach of hostile aircraft, the organization of the radar watch is being improved and is being more fully linked with the system on the Continent.

Following upon the decision, announced a year ago, that it was not practicable to attempt to defend the country as a whole against nuclear attack, Fighter Command now has the more limited task of protecting the bomber bases; and its strength is being correspondingly reduced. When the Russians, in addition to manned bombers, have ballistic rockets in sufficient numbers, capable of knocking out airfields in Britain, the value of a fighter defence system will obviously decrease; and the same will apply to a missile defence system, effective only against aircraft. But that point has not yet been reached. Meanwhile, the squadrons of Fighter Command will continue to play their part in defending the deterrent. British short-range ground-to-air missiles will begin to be deployed during the coming year, and a longer range type is in course of development. In the testing of these and other weapons the Woomera rocket range is playing an invaluable part.

Now that Britain has a substantial strategic bomber force and a growing stockpile of nuclear weapons of her own, it has become necessary to co-ordinate operational plans with the U.S.A.F.

Britain's expenditure on the strategic bomber force and its nuclear bombs, and on related research and development (including work on ballistic rockets) represents less than one-tenth of the Defence Estimates for 1958-59. The fighter force and the control and warning system, together with research and development on fighters and defensive guided missiles, represents an approximately similar amount. Together they add up to between 15 per cent and 20 per cent of the total Defence Estimates. On the basis of present plans and estimates, it does not seem likely that these costs will increase significantly over the next few years.

The Western nuclear deterrent will shortly be supplemented by Intermediate-Range Ballistic Missiles, and Her Majesty's Government have accepted the offer of the United States Government to supply Britain with such weapons. The Agreement setting out this arrangement will be completed very shortly and its terms will be published.

A British ballistic rocket of a more advanced type is being developed on the highest priority, in close co-operation with the United States. This is being designed for launching from underground.

Conventional Forces

At present R.A.F. Transport Command is equipped with Hastings and Comet aircraft for long-distance lifts and with Beverleys for transportation within the theatre of operations. These will be supplemented by Britannias, of which twenty have been ordered. This will greatly expand the Command's long-range troop-carrying capacity.

Sea Power

The Eastern Fleet will be based on Singapore. It will be composed of one aircraft carrier (with a balanced complement of strike, fighter and anti-submarine aircraft), one cruiser, and a number of destroyers, frigates and smaller vessels. It will also include a converted carrier, equipped to accommodate a Marine Commando force and capable of operating helicopters for either the troop-carrying or anti-submarine rôle.

A number of important projects are in hand to ensure that the Royal Navy will in the years ahead continue to keep abreast of the times. A new comprehensive radar and aircraft control system for carriers, more advanced than any other in service elsewhere, has been introduced. A low-level tactical bomber is being developed for the Royal Navy, and its adoption by the Royal Air Force is being considered; the prototype will fly later this year. The development of a nuclear submarine is proceeding, with the valuable co-operation of the United States.

ROLLS-ROYCE
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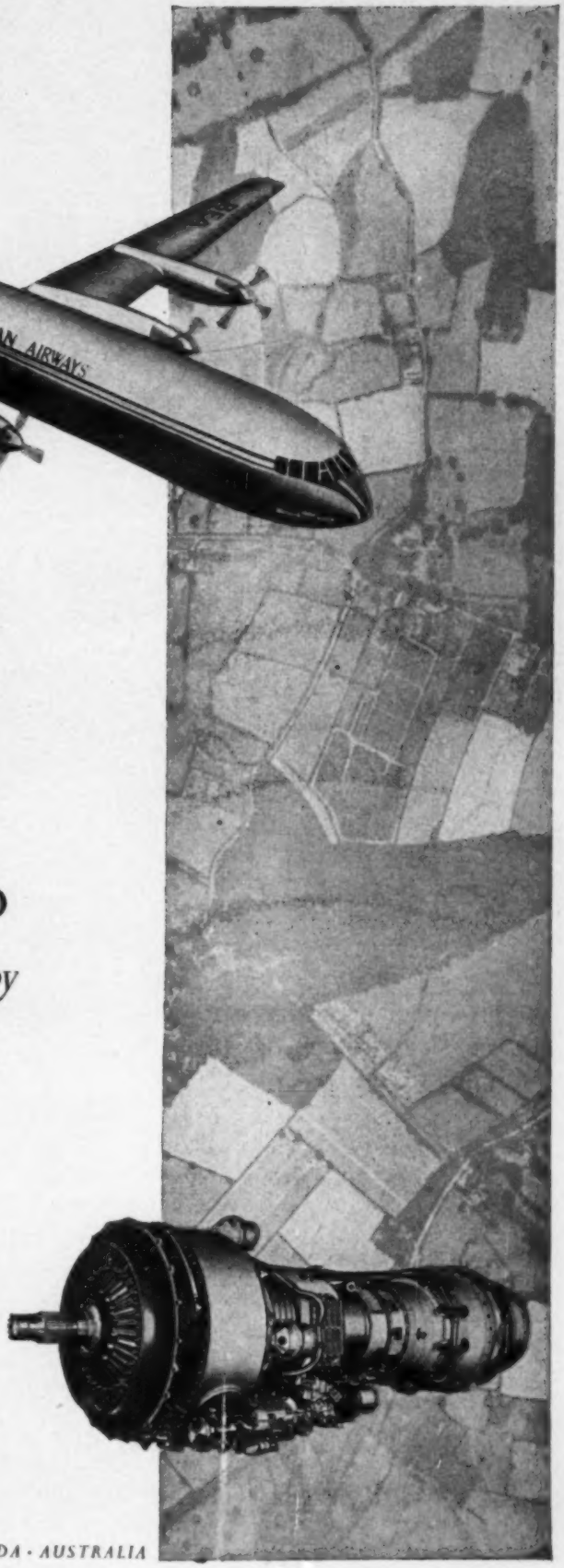
PROP-JETS
power the
VICKERS VANGUARD

Vanguards have been ordered by British European Airways and Trans-Canada Air Lines



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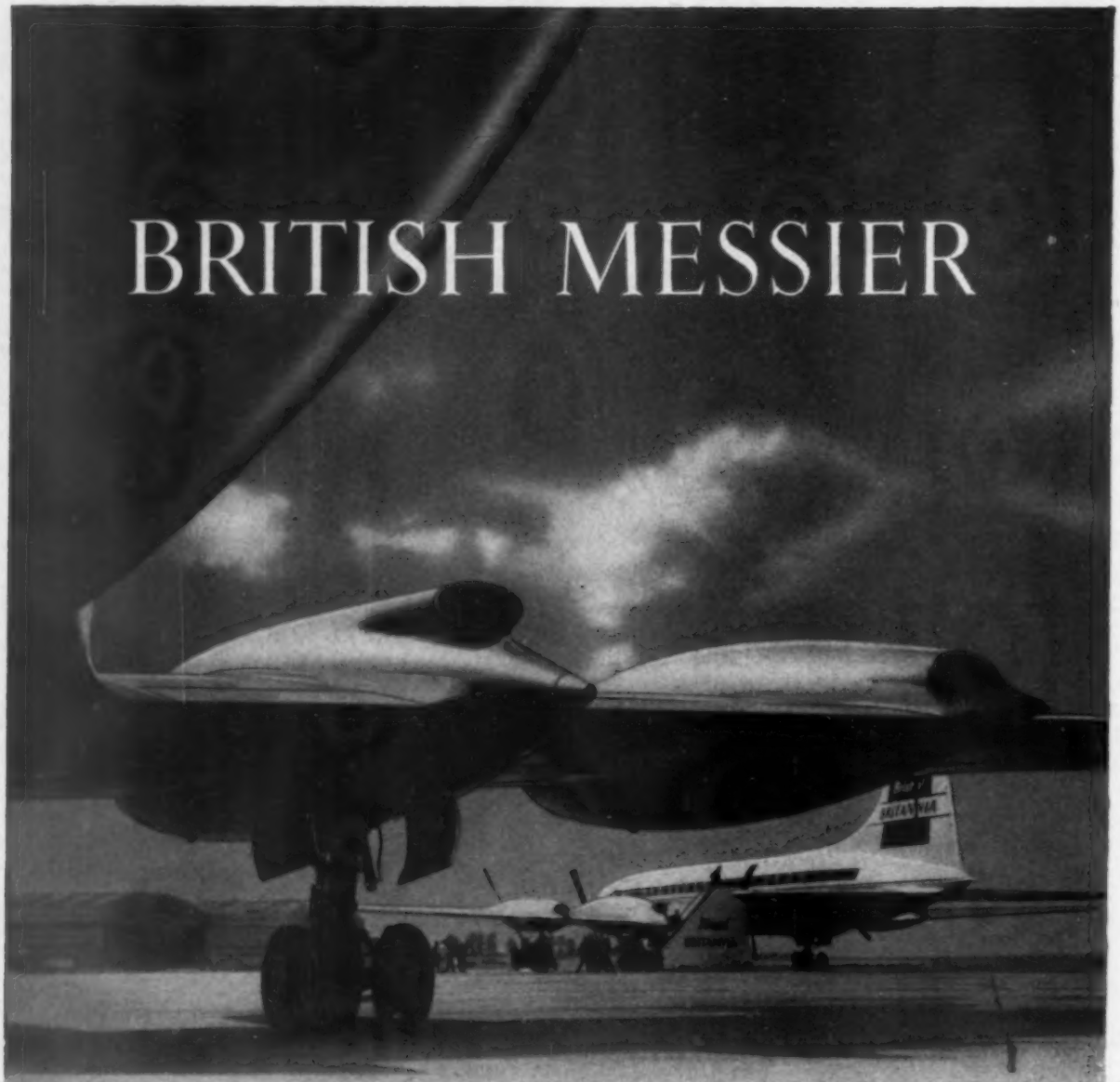

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HERE AND THERE

Protracted Hustle

CONVAIR stated last week that a B-58 Hustler had flown supersonically for over 90 min. The prototype Hustler—America's first supersonic bomber—made its first flight on November 11 last. (As we go to press it is reported that an F-104 has flown supersonically for over 60 min.

Sale of Junkers

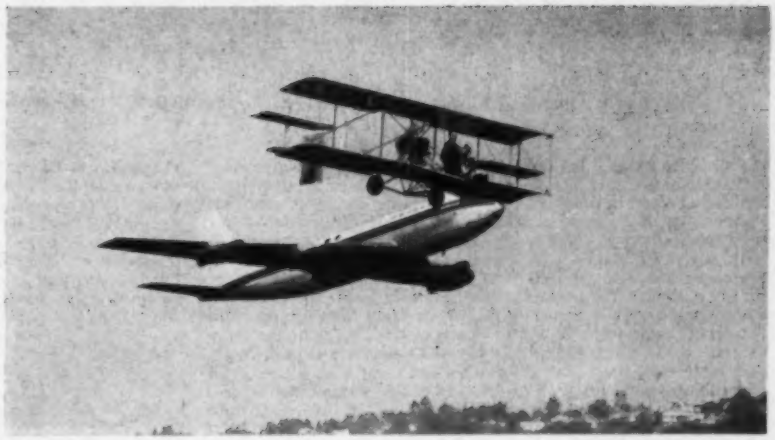
THE Junkers aircraft and engine firm, which since the war has been administered by the West German Government, was sold last week to private enterprise—the Heinkel/Messerschmitt consortium known as Union Sued Flugzeugbau.

The Endurance of a Comet

ONE of B.O.A.C.'s two D.H. Comet 2Es landed last Monday after a non-stop flight of approximately 3,600 st. miles in 8hr 6min —the longest flight ever made by a Comet. The pilot was Capt. J. A. Kelly, and the route was London - Brindisi - London - Geneva - London. Approximately 900 gal of fuel remained.

E.N.V. Founder's Passing

BRITAIN has lost a pioneer aero-engine constructor by the death, which occurred recently, of Mr. Alexander Edwards Hukins, whose E.N.V. engines powered many aircraft of the pre-1914 era. The business which he founded, the E.N.V. Engineering Co., Ltd., is still well known in the aircraft industry today, as a manufacturer of precision gears.



PUSHERS BOTH: Pete Bowers, a Boeing flight-test engineer, is overtaken in his 1912 Curtiss bi-plane by the Boeing 707 jet transport prototype. The 707 flew past, by arrangement, at 180 m.p.h., and as it came into sight Bowers took off, headed by a photographer-laden car which kept pace at about 60 m.p.h.

Douglas European Appointment

MR. JOHN W. SHAVER has been appointed European military sales representative at the Geneva office of Douglas Aircraft Company. He joined them in 1946, having previously served in the U.S. Navy for four years during the war. Prior to his European appointment he was assistant project engineer on the A3D Skywarrior.

Rocket Boost

WITH the aim of impressing young British scientific and technical students with the potentialities of rocket travel in the space age, the Air League is to hold a youth conference on April 14 at Royal Festival Hall, London. The meeting is to be addressed by the Duke of Edinburgh, and other speakers will include Mr. G. R. Jefferson of English Electric, Mr. G. C. I. Gardiner of the de Havilland Propeller Company, a scientist from the R.A.E., and Mr. A. V. Cleaver of Rolls-Royce, Ltd. The chairman will be Marshal of the Royal Air Force Sir Dermot Boyle.

TRACTORS BOTH: Two new single-strut-braced cabin monoplanes from the Continent. Uppermost is the Nord 3400 observation aircraft, which can take off and land in about 100 yards, though it cruises at over 124 m.p.h. The engine is a Potez 4D30 of 240 h.p. The second machine is the Italian Partenavia P.57 Fachiro, a 2/4-seater with 150 h.p. Lycoming O-320.

Thinking About a Car?

TODAY, February 21, *The Autocar* is publishing its special *Choosing a Car* number. New cars are reviewed in the light of the journal's road tests, while for the prospective buyer of a used vehicle there is detailed advice on points to watch and costs of repairs and replacements.

Russian Bedstead

DESCRIBING in a Soviet technology magazine the development of the Turbolet "flying bedstead" aircraft, Dr. Matveyev, engineer Kvashnin and test pilot Garnayev claim that it will become a prototype for supersonic jet airliners which will take off from city squares. The first Turbolet has "successfully passed its tests," and "control of the machine by means of gas stream and jet rudders proved not only possible but perfectly reliable."

French Ejection Seats

TWO new French ejection seats were recently certificated after live tests at Melun-Villaroche. They are the Sud Aviation type E97, for the Vautour; and the E92, a fully automatic version of a seat already in service. The E97 was "ridden" by W/O. Marcel Tournier, who last year made a very-high-speed test ejection in a Martin-Baker seat in England. The other tester was W/O. René Favier.

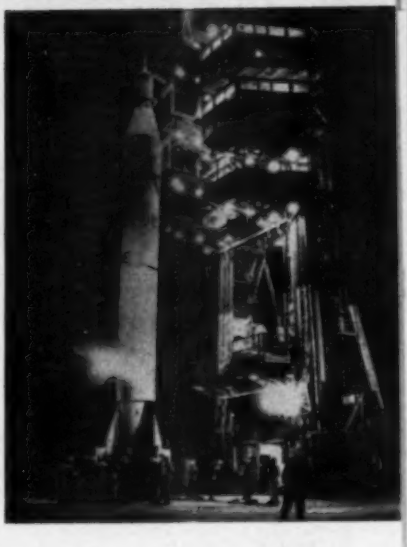
Lecture on Dectra

ENTITLED *Dectra—a Long-range Navigational Aid*, a paper will be presented by Mr. C. Powell and Mr. D. A. Hendley to the British Institution of Radio Engineers on February 26 at 6.30 p.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1. Mr. Powell is head of the survey and special projects department of the Decca Navigator Co., Ltd., and was formerly with the Army Operational Research Group. Mr. Hendley, who is chief design engineer on the Dectra project, was previously with the Navigation Aids division of the Admiralty Signal Establishment.

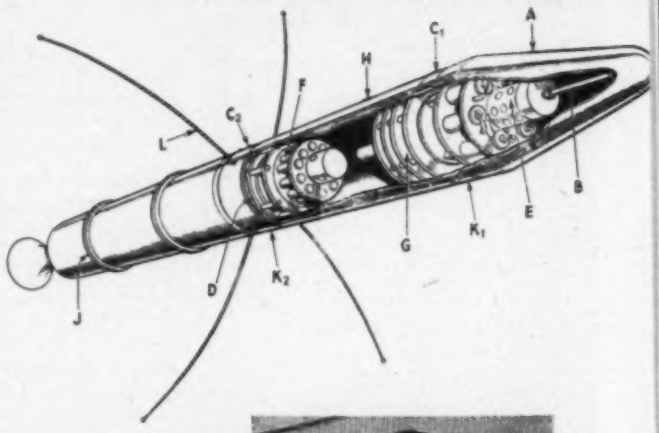
EXPLORER

FURTHER DETAILS OF THE U.S. ARMY'S SATELLITE

ON this page are photographs and drawings giving additional information on the satellite Explorer and its carrying vehicle, successfully put into an orbit by the U.S. Army on January 31. Preliminary details and a firing picture were published in our issue of February 7. The first-stage vehicle was basically a Redstone, with lengthened tankage and a special fuel—Hydyne, developed originally by Rocketdyne, the manufacturers of the rocket motor, with properties similar to alcohol but based on hydrazine—giving a thrust of 83,000 lb and about 12 per cent longer burning time. Subsequent stages are shown in the large diagram below. The satellite itself was a cylinder 6in in diameter and some 80in long (including 4th-stage case) with a weight of 30.8 lb and a payload of 18.13 lb. One of the photographs on this page shows the spin-launcher assembly. The flight sequence was as follows: 1st-stage burn-out at 160 sec (6,800 m.p.h. at 53 miles altitude); 2nd-stage ignition by radio control after coasting to between 200 and 220 miles some 400 sec after launching; ignition of the 3rd and 4th stages; and final burn-out of the 4th stage at a speed of 18,000 m.p.h. in an orbit with perigee and apogee at 230 and 1,600 miles.

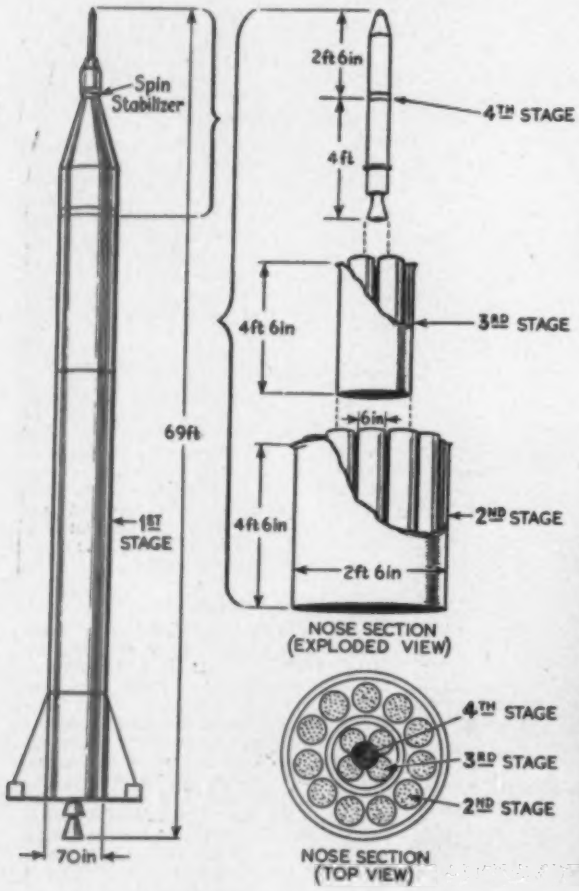


The lengthened Redstone is termed a Jupiter C, although it bears little resemblance to the IRBM of that name. This striking photograph shows the vehicle at Patrick A.F.B., Cape Canaveral, shortly before firing on January 31.



(Right) Principal features of the satellite and 4th-stage motor:—A, nose cone; B, temperature probe; C_1, C_2, external temperature gauges; D, internal temperature gauge; E, low-power transmitter; F, high-power transmitter; G, cosmic ray and micrometeorite package; H, micrometeorite impact microphone; J, micrometeorite erosion gauges (on 4th-stage case); K_1, K_2, glass-fibre rings; L, turnstile-type aerials with end-weights.

(Below) The various units making up the complete four-stage satellite-launching equipment. A total of sixteen scaled-down Sergeant solid-propellant motors power the 2nd, 3rd and 4th stages.



(Right) The 1st-stage nose and spin-launcher containing subsequent stages. Eleven minutes before launching, the drum was rotated at some 560 r.p.m., increased to 750 r.p.m. at launching to provide gyroscopic stabilization and equal thrust-distribution. The component was built by Reynolds Metals in Sheffield, Alabama.

(Below) The satellite itself, held by three of those chiefly responsible: Dr. William Pickering, Mr. James A. van Allen and Dr. von Braun.

Flying above the sub-tropical jet stream

This is an artist's impression of flight on the direct South Africa-Australia route during the next decade or so. It illustrates the aircraft at 25,000 feet above the sub-tropical jet stream, in latitude 35°S over the southern tip of Western Australia.

The mean axis of the southern sub-tropical jet stream shown above is about 40,000 feet, and like its northern counterpart, is an east-flowing band about 500 miles across, with speeds varying from 50 to 100 knots, and at times reaching 250 knots.

Associated with thermal boundaries between air masses, the jet stream is often revealed by characteristic cloud formations at the base of the stratosphere — and operators of the powerful multi-jet airliners of the future will find these jet streams an important factor in flight planning.

Flights at such altitudes, involving supersonic speeds and great thermal extremes, will demand the special petroleum products which are now being developed by Esso Research.

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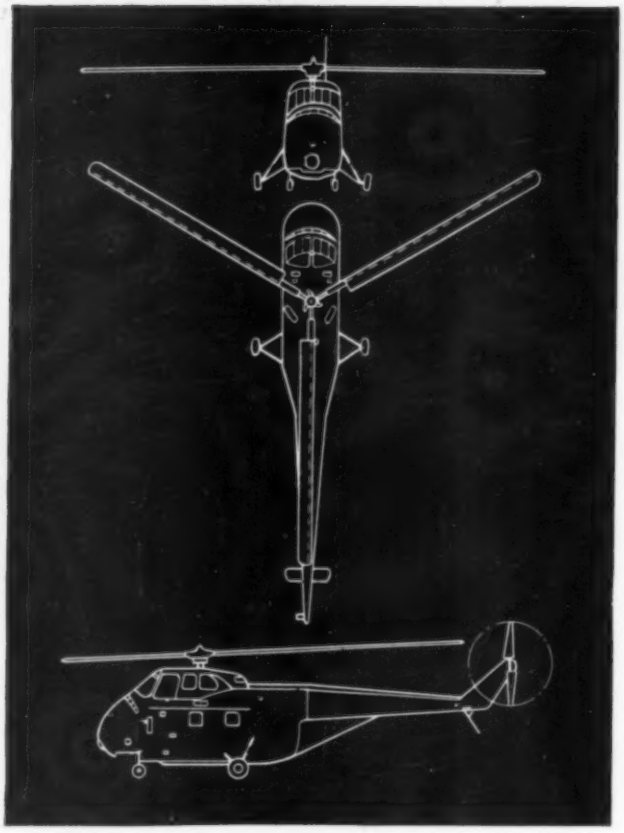

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Further particulars of these and other instruments are available upon request.

Westland Whirlwind cockpit (Photograph by courtesy of B.E.A.)

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National Shares in Air Transport

The Latest Available Figures Analysed

WITH 1958 already well under way there is something academically remote about an analysis of the fast-moving air transport industry as at the end of 1956. But only now is complete information available (in the form of the I.C.A.O. *Digest of Statistics No. 65, Traffic 1947-1956*), and still many of the 1956 figures are provisional. By enabling a list to be compiled of the 70 member-states (excluding U.S.S.R. and Red China) in order of importance, these statistics provide good fuel for nationalist furnaces. For the record, this article sets out to trace the progress of the leading countries in air-transport.

Starting in the field of passenger traffic, the United States continues to dominate the world picture despite a gradual post-war fall in its proportion of world traffic from 70 per cent immediately after the war to below 65 per cent in 1956. Americans generally do not interpret this decline as proof either of their industry's lack of vigour or of weakness on the part of private enterprise, but as a logical result of the development of civil aviation elsewhere, invariably starting from scratch.

Far below the giant U.S., but well ahead of all other countries, lies a cluster of seven leading States comprising, in order of importance, the United Kingdom, France, Canada, Australia, Brazil, Netherlands and Mexico. Together, these seven countries contribute 23 per cent of the total world passenger traffic, leaving only 14 per cent to be shared among the 62 other member-States.

Since 1950 the second place has been held by the U.K. despite a slackening in Britain's rate of passenger traffic growth after withdrawal of the Comets in 1954. The experience of B.O.A.C. and B.E.A. in 1957 suggests that the U.K. has again drawn away from France. Since 1953, figures for the U.K. include traffic carried by colonial airlines. If this traffic is excluded, British airlines are seen to carry a steady 4-5 per cent of world traffic.

Statistics for the No. 3 country, France, can be easily misinterpreted. Unlike other countries, traffic carried on non-scheduled flights is not excluded by France from traffic figures. And until the end of 1953 only Air France's traffic was considered. Although the total volume of traffic and the rate of growth for this country has accordingly been exaggerated in recent years, this rise is more than a statistical fiction, for U.A.T. and T.A.I. have grown rapidly, and Air France has also expanded, apparently at the expense of B.O.A.C.

Despite the fact that Canada is the fastest growing of the "big eight," and although preliminary figures suggest that this country's growth rate in 1957 was faster than its national rivals, there still remains some distance to cover before Canada's passenger traffic challenges Britain and France.

Whereas Canadians look back with pride on a record of unrivalled progress, Australians have cause for sadness when contemplating the traffic record, their country having toppled from a strong second place immediately after the war to an insecure fifth place in 1956. A fall in wool prices was the main factor in pegging Australian air traffic at about the same level for four years until 1955 when the economy gained momentum and traffic again started to climb. The economy wavered once again last year, and it is possible that Australia might have fallen to sixth or seventh position in 1957, having been overtaken by Brazil and the Netherlands. Except in 1948, Brazil's post-war passenger traffic has always been slightly ahead of that for the Netherlands. The gap has been narrowing since 1951, and publication of 1957 statistics might well show that Brazil has dropped behind.

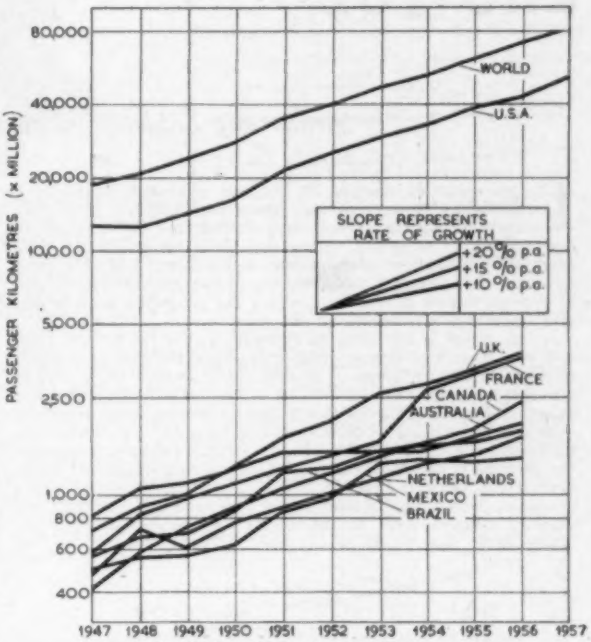
Some way behind Australia, Brazil and the Netherlands comes the smallest of the big eight, Mexico. This country's air traffic grew steadily until 1953, but has subsequently been stationary. Despite this stagnation, Mexico still shows over twice the passenger traffic of the next country on the list, Belgium.

Excluding each of the big eight, no country has ever shown over 500 million passenger-miles in a year, and none contributes more than one per cent of the world passenger total.

Looking at the national distribution of air-freight, the U.S. again dominates the scene, having since the war accounted for just over one-half the world total.

With one exception, the same names are included among the big eight as was the case with passenger-traffic. The one exception is Canada, whose place is taken by Colombia. In 1956, the seven countries following the U.S. are, in order of importance, France, U.K., Australia, the Netherlands, Colombia, Mexico and Brazil. Together these provide for 30 per cent of total world air-freight traffic. The remaining 62 member-States contribute 16 per cent.

The post-war experience of Colombia in the freight field mirrors that of Australia in the passenger market. Until 1951 this country lay second to the U.S., but a combination of an unsteady economy and improving surface transport has prevented further traffic growth, Colombia now being relegated to sixth place. France and the U.K. now fight for second place, French inclusion of non-scheduled traffic making it impossible to decide exactly which of the two is still in the lead. Australia's position has deteriorated from third place held until 1951 down to fourth place today. The Netherlands, now lying fifth, only overtook Colombia in 1957.



Post-war distribution of passenger traffic by countries.

Freight statistics for the last two of the big eight, Mexico and Brazil, are insufficiently reliable to establish more than their approximate position between Colombia on the one hand and Canada and India on the other. Brazil is often quoted erroneously as the world's second main air-freight country, this misconception arising through the inclusion of all passenger baggage with freight. Mexican statistics have never been comprehensively reported, and the national total has therefore to be estimated.

The national pattern of airmail distribution contrasts strongly with that for passengers and freight. For instance, the U.S. has steadily increased its share from 50 per cent in 1948 to nearly 60 per cent today. Whereas the U.K. and France are close rivals as regards the carriage of passengers and freight, there is a wide gap between these two countries in the case of airmail, the U.K. showing a constant nine per cent of the world total as against six per cent for France.

Canada and Australia have always shared fourth and fifth positions, and at present each is responsible for three per cent of the world total. The fastest-growing of the leading countries in this field, Canada, overtook its sister-dominion in 1955 after Australian mail traffic had been stagnating for some years.

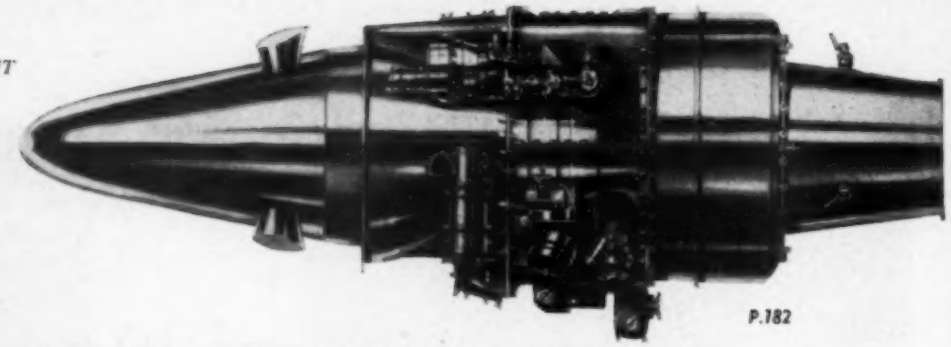
In order of importance, the next two countries are India and Mexico, each accounting for two per cent of the world total. Statistics for Mexico have once again to be estimated by I.C.A.O., but after some years of jostling with India it now appears that Mexico has fallen behind.

Last among the big eight is Belgium, most of its mail traffic moving between the parent country and the Congo. By contributing 1.5 per cent to the world total, Belgium brings the share of the big eight to 72 per cent, leaving the remaining I.C.A.O. members to share 28 per cent. That this last proportion is about double that shown in the case of passenger and freight traffic for this group of smaller countries is a reflection of the monopoly that most national airlines have over the mail supplied by their postal authorities.

A brief survey of the whole field shows the U.S. with one-half to two-thirds of world air traffic, while the U.K. and France share a further 10-15 per cent. Who favours proportional voting in I.C.A.O. and I.A.T.A.?

J. C. S.

P.181 and 182

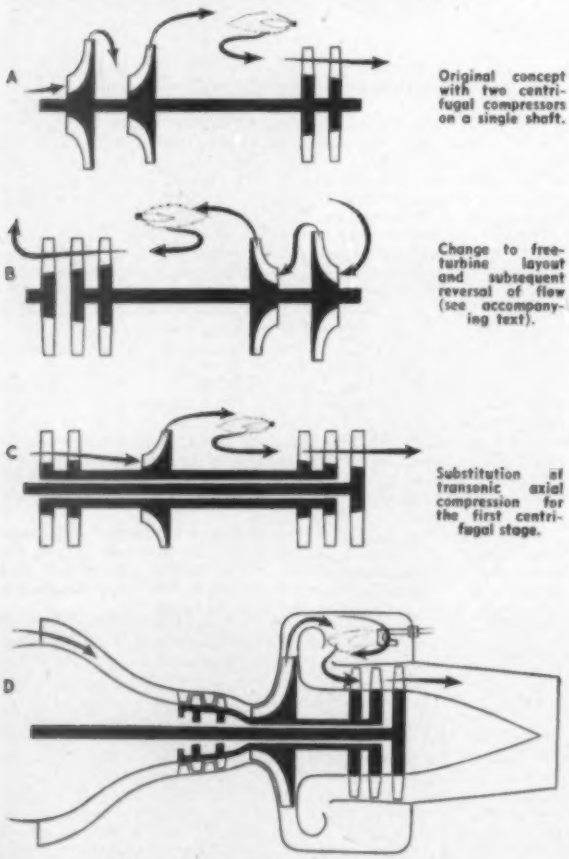


P.182

Armstrong Siddeley Motors' 1,000 s.h.p. Units

IN our issue of August 30 last, we published preliminary information concerning the Armstrong Siddeley P.181/182 turboshaft engines, which were then in the initial stages of development at Coventry. Since that date the design has been changed in a number of important respects and has now been developed in a different configuration. It is appropriate, therefore, to give an outline of the form which the prototype engines will take when they appear later in the year.

As we noted in our issue of February 7, the 1,000-s.h.p. class is a very important one for both aeroplanes and helicopters, not to mention the profusion of curious STOL and VTOL devices which will link the two. In contrast to the position which obtained as recently as 1956, the 1,000 h.p. market is now being wooed by a variety of competitive turboshaft engines; only two weeks ago, for example, we announced the Napier Gazelle Junior and reported the decision of the de Havilland Engine Co. to manufacture under licence the General Electric T58. In spite of this competitive situation, Armstrong Siddeley Motors are unshaken in their decision to proceed with an engine in this class, and they are undoubtedly wise to do so. Unlike its British competitors, the P.181/182 design is a completely new one, and the company's long experience and general record in the field of gas-turbine aero engines is such that the design must be considered very seriously indeed. It is still too early to attempt a detailed engineering appraisal, with a cutaway drawing, but the time is appropriate for a general review of the company's thinking together with an assessment of their new engine design as it exists at present in definitive form.


A
Original concept with two centrifugal compressors on a single shaft.
B
Change to free-turbine layout and subsequent reversal of flow (see accompanying text).
C
Substitution of transonic axial compression for the first centrifugal stage.
D

The schematic diagrams above illustrate the evolution of the present P.182 (the lowermost sketch) from the original conception shown at the top. The letters A, B, C and D denote each development stage as described in the text. The sketches are not geometrically accurate.

An obvious need for a 1,000 s.h.p. engine was recognized by Armstrong Siddeley in the autumn of 1956 and the company thereupon started a general and informal investigation into the possible market. Serious thoughts of designing an engine crystallized in the early part of last year when it was clear that such a unit would be eminently suitable for several projected aeroplanes and helicopters. From the outset Armstrong Siddeley gave the factors of purchase price and maintenance cost priority over those of specific fuel consumption and powerplant weight. During the twelve months that the engine has been under development the company has seen no reason to change this policy.

In the first half of last year the management of the Hawker Siddeley Group authorized the company to spend a very considerable sum on design studies and, ultimately, on the construction of prototypes. Work went ahead, under the company project numbers of 181 and 182 for the helicopter and turboprop versions respectively. At the Paris *Salon*, at the beginning of June, the company's representatives were armed with a small number of preliminary brochures and performance estimates, and discussions were held with several interested airframe manufacturers in order to test the design's reception and the general climate of the market. At this time the project had a layout essentially similar to that of the Rolls-Royce Dart, namely a single-shaft configuration with a ram intake at the front to two centrifugal compressors (depicted at A in an accompanying diagram).

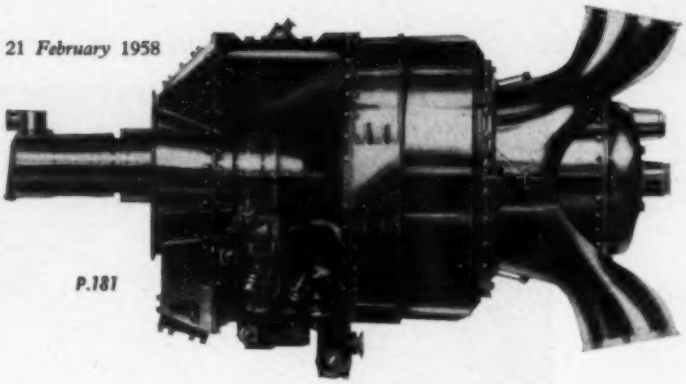
During the summer it was decided that the advantages of having an independent power turbine outweighed the resulting increase in complication, and accordingly a free-turbine variant was planned. It was immediately found that the opening out of the compressor assembly—in order to permit the power shaft to pass down the centre—resulted in a substantial increase in diameter and weight. The engine was therefore turned back-to-front, the intake being located at the rear and the turbines and output shaft (and exhaust) at the front. It was at this stage that the design was first placed on public view, at the S.B.A.C. exhibition in September, and the general layout at this period is depicted as B in the schematic illustration.

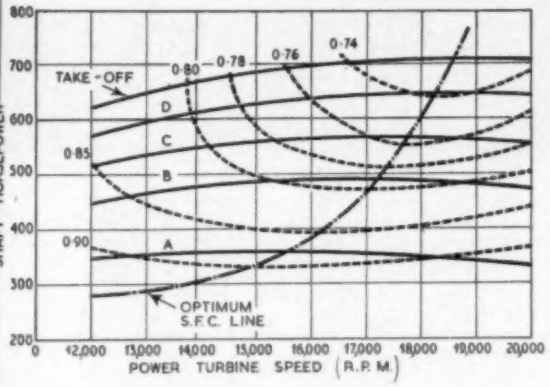
During the autumn it was decided to replace the low-pressure centrifugal compressor with a pair of transonic axial stages (thus producing an engine similar to the latest in the Turboméca series, with a design pressure ratio of about 6.5). Elimination of the first centrifugal stage removed the restriction on hub diameter at this point, and it was thus possible to turn the engine "the right way round" once more (with the intake at the front and the drive-shaft passing down the centre—C in the diagram).

Possibly this is the optimum layout; but the company are determined that the development of the engine shall be as smooth and rapid as possible and, as a measure of prudence, it has been decided that the first generation in the P.181/182 family will not employ the transonic compressor but will have instead two subsonic axial stages (D in the diagram). Detail design of this engine has been under way for some months and is now virtually fixed; drawings are being issued to the shops for prototype manufacture and it is hoped to run the first engine shortly after the middle of the year.

In general the P.181 and P.182 are being developed in parallel, and common components will be employed wherever possible. The demand for the helicopter engine is probably the more imminent and, although the P.182 turboprop is somewhat simpler and requires less specialized test equipment for its development, it is likely that the helicopter engine will be the first to run.

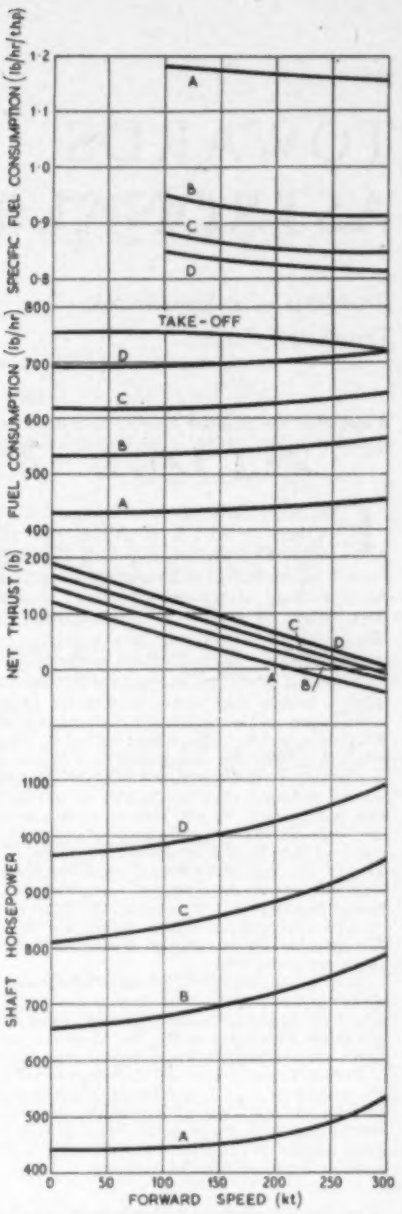
Possibly the kernel of a gas turbine is its compressor. The low-pressure compressor consists of two conventional axial stages with unshrouded blades mounted in ring-type discs. The rear face of the second disc is welded to a steel "bottle shaft," of





(Right) Sea-level performance of the P.182 under I.S.A. conditions. A propeller efficiency of 80 per cent is assumed and the cruising ratings pre-suppose a power-turbine speed of 17,000 r.p.m. The letters are: A, 17,400 r.p.m., lower cruise II; B, 18,300 r.p.m., lower cruise I; C, 18,800 r.p.m. max. recommended; D, 19,300 r.p.m. max. continuous.

(Left) Flight performance for the P.182 at 20,000ft and 200 kt assuming a propeller efficiency of 80 per cent. Parameters shown are shaft power and specific fuel consumption.



substantially conical form, on the rear end of which is mounted an unshrouded light-alloy centrifugal stage. The mean diameter of the gas path is markedly reduced between the second axial stage and the eye of the centrifugal impeller. The stator blades are mounted in upper and lower half-casings which contain, respectively, an integrally cast oil tank and accessory gearbox.

Much Mamba experience has been built into the design of the turbine, particularly with regard to disc cooling and stator mounting. The first two turbine stages are directly coupled to the compressor to form a gas-generator assembly, and the third stage is mounted on the mechanically independent output shaft. Rotor-blade materials are respectively N.100, N.90 and N.90, and the stators will either be in G.39 or in cast N.90. All the rotor blades have extended roots of the type pioneered by Rolls-Royce; Armstrong Siddeley call them "stand-off" roots. Unusually, shrouds are fitted only to the second and third rotor stages, it having been found that on the first stage the increased centrifugal load due to shrouds would impose an inordinate restriction upon maximum blade temperature.

The gas-generator assembly is arranged as a single unit with no axial play between the turbine and compressor, and the two-stage compressor-turbine is overhung from a split-race ball-bearing which acts as a common thrust bearing. The considerable diameter of the tubular drive-shaft makes the whole assembly rigid and its overall length is in any case very modest. A roller bearing is mounted ahead of the first-stage compressor disc. The power turbine is carried on a shaft with a rear ball thrust-bearing straddle-mounted in the exhaust cone and a roller bearing immediately ahead of the turbine disc. Its extension shaft is connected to the turbine shaft through a splined coupling which permits axial play, and the output shaft ahead of this point is opened out in diameter to increase its whirling speed, there being ample room within the gas-generator assembly for this to be done. At the front is a coupling and ball and roller bearings close behind the main reduction gear.

Armstrong Siddeley have advisedly put a lot of weight into the reduction gear, partly in order to increase the overall factors of safety and thus minimize development trouble, and partly in order to make provision for considerable "stretch" and thus facilitate future up-rating of the engine. In the P.182 the reduction gear occupies a large centre-body supported within the magnesium-zirconium intake by three aerofoil struts. The gearing itself is of somewhat unusual form. Owing to the high rotational speed double-helical gears are used in the layshaft of the first reduction stage, but in the final output stage the epicyclic planet gears turn relatively slowly, thus permitting the use of straight-cut teeth and the elimination of planet thrust bearings. A typical reduction ratio is 13.82 : 1 which results in a maximum propeller speed of 1,448 r.p.m.

One of the few factors which has remained essentially unchanged through all the evolutionary stages of the engine is the combustion system. Logically enough this adheres to the Armstrong Siddeley policy of a truly-annular chamber with "walking-stick" vaporizing burners. The design does, however, differ from the company's earlier engines in being folded back on itself to give a considerable amount of reverse flow. In many respects the design is somewhat similar to that used in the Lycoming T53 and T55, and the greater part of the total mass-flow passes radially inward to the turbine nozzles and only the primary combustion air passes to the rear of the chamber and thence axially forward. The burners are mounted around the rear face of the chamber. This face also carries the six powerplant mounting points, the engine being installed on a triangulation of tubular struts, with all loads initially passed through the combustion-chamber outer casing.

A typical cowled P.182 should have exceptionally low drag; all normal accessories fit neatly around the slim axial compressor and the intake and exhaust arrangements are as near to the optimum as can be achieved. A typical propeller will be a Rotol unit with four solid blades having a diameter of 11ft (or 12ft, where take-off thrust is particularly important), and the heading illustration shows the elongated spinner which has been found to produce the optimum flow over the roots of the blades. Incorporated in the reduction gear is a torquemeter somewhat similar to that employed in the Mamba. There are two accessory drives, each rated at 50 h.p.; one connects the gas generator to the main box on the underside of the engine and the other is angled off the power-output shaft on the port side of the intake casting. The latter shaft naturally drives such units as the p.c.u., torque-meter pump and percentage propeller tachometer. The main

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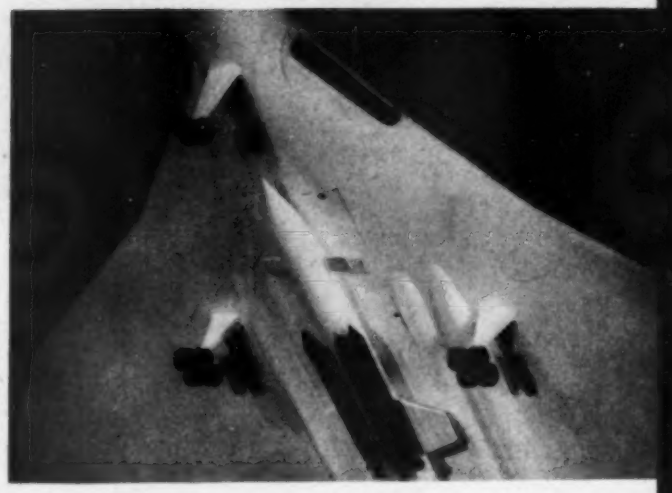
TOWARDS ASTRONAUTICS

Problems of a Significant Transition Period



A model of the proposed high-altitude aerodynamic research vehicle described in this article, in position for air-launching from a Vulcan.

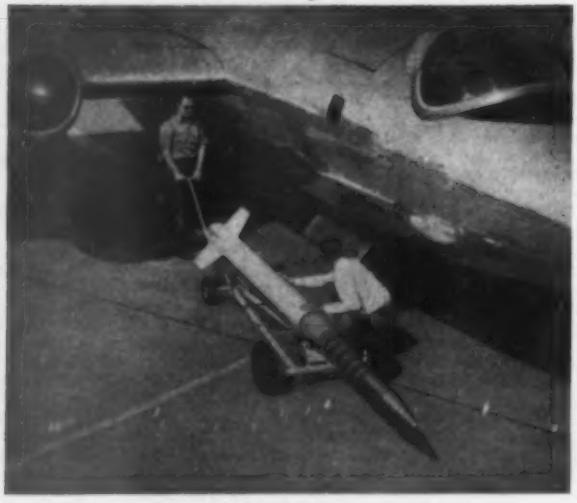
"FROM Aviation to Astronautics" was the title of a lecture given by Mr. J. E. Allen, B.Sc.(Eng.), A.F.R.Ae.S., A.M.I.Mech.E., F.B.I.S., before the Manchester branch of the Royal Aeronautical Society on January 22. Mr. Allen is head of the aerodynamics, projects and assessment department of the A. V. Roe weapons research division at Woodford. The first part of the paper contained a review of current high-altitude aircraft, guided weapons, high-altitude rockets and satellites; the second section was devoted to future design trends and some immediate targets in space-flight.

Referring in his historical introduction to the significance of the Russian sputniks, Mr. Allen said that, from its inception, the satellite, unlike the aeroplane, had drawn extensively from the practical and theoretical knowledge established in other fields. These included electronics, guided missiles, automatic systems and aeronautics. It was this latter fact which made the present transition period so significant to the science of aeronautics. If no one had prophesied interplanetary flight, it appeared that aeronautics, for its own reasons, would have had to develop the same technologies. In the course of time, however, interplanetary flight would produce its own devices and principles, such as ionic and nuclear powerplants, which might not have any application on this planet. Extracts from the second portion of Mr. Allen's paper are given below.

It is a common observation [the lecturer stated] that no new device or invention can flourish in the world before its time. The many branches of technology associated with aeronautics have gradually developed in the last 15 years and the advent of space flight may be regarded as a logical outcome of this work.

Rocket propulsion is the only means yet available for escaping the gravity of the earth. Many billions of pounds have been spent in research and development of the large liquid-rocket motors in connection with the V.2 and later ICBM ballistic rockets. The performance of the latter is of the same order as that needed for satellite flights of smaller payloads.

A two-stage hypersonic rocket being prepared for air-launched flight test from a B-57A in the propulsion-research programme of the N.A.C.A.'s Lewis Laboratory.



Guidance for aircraft and missiles has, in automatic inertial and celestial navigation, deserted purely earth-bound aids to seek the references of inertial space and the stars. The precision of navigation needed for aircraft, missile and elementary space-flight can be attained by comparable instrumental techniques. Associated with these guidance developments are those of complex electronic control and computing equipment. The need to cram quarts of electronic brains into pint pots of small intercepter missiles has given a remarkable impetus to miniaturization techniques such as transistors, digital systems and printed circuits. Recent work indicates that there are still many advances to be made along this road. In the early days of space-flight, when performance margins are small, miniaturized equipment will pay dividends in extending physical experiments to greater distances.

In the piston-engined aeroplane, "performance" was defined quite adequately by level-speed and rate-of-climb values, changing with the introduction of jet aircraft to include zooming effects. Missile trajectories take this a stage further, depending almost completely on complex digital computers for their evaluation. For advanced missiles one can no longer consider the earth as flat—a liberty which aeronautics has been able to take for the sake of mathematical simplicity for over 50 years. For ballistic missiles, satellites and interplanetary flights the flight paths are now called orbits and will be solved by means of celestial mechanics, established by astronomers many centuries ago. Already maximum altitude is called "apogee" and minimum altitude "perigee."

There has been a major revolution in aerodynamics since 1940. Until then virtually all aeronautical applications were subsonic and it was obvious that much research was necessary for a better understanding of the theory of lift, drag, propulsion and interference for application with greater certainty in design. Since then, aerodynamics has progressed through the transonic and supersonic regions to hypersonics. Mach numbers of 23 have been measured in free flight and 50 and 200 (nominal) in the laboratory. We can now truly say that a vast area of aerodynamics has been tentatively explored, for there is no virtue in hurtling through the atmosphere at speeds exceeding satellite velocity. There is a tremendous amount of research still to be done, but the broad physical characteristics of the different regimes have been mapped.

Consider the stagnation temperature associated with flight at various Mach numbers through the atmosphere. Temperatures up to 8,000 deg K will exist behind the strong normal shock waves created by a blunt body. As the internal energy of the air increases, the higher energy levels (such as vibration, disassociation, electronics and ionization) are excited, resulting in much lower temperatures than those obtained from ideal gas theory.

In addition to changes associated with the physics of the air at high temperatures, certain chemical transformations take place. At room temperature, air consists of approximately 78 per cent N_2 and 21 per cent O_2 (by volume), with traces of other substances such as water vapour and argon. At higher temperatures the air contains oxygen and nitrogen in both molecular and atomic forms; and nitric oxide, free electrons and ions may also be present.

At very high temperatures free electrons are produced and these, moving in the boundary layer and wake, induce luminous discharges and electro-magnetic effects. Aerodynamics and astrophysics are brought closely together by the science of magneto-hydrodynamics, which deals *inter alia* with the formation of sunspots and solar prominences and the creation of radio noise in outer galaxies, and also with the influence of conducting fluids on

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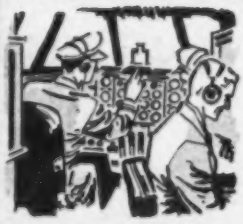

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The increased accuracy of navigation which the AD 2300 makes possible and the continuous flow of information which reveals instantly the effect of weather changes on the courses and speeds made good, enable pilots to achieve optimum flight paths. Self-contained navigation maintains your flexibility in operation and helps you to operate regularly and economically.

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The AD 2300 series provides automatically and without reference to ground based aids: (a) Position in latitude and longitude. (b) Distance to go on a 'leg' or to destination on a 'great circle' or rhumb line track. (c) Wind speed and direction. (d) Ground speed. (e) Drift angle. (f) Steering information to Flight System or Autopilot to maintain the selected track.

...closer separation

The AD 2300 assists the pilot accurately to maintain his planned track. (The steering information can be fed directly into an Autopilot or flight system if required). It also enables the navigator to give ATC precise and reliable position reports and accurate E.T.A.'s and to keep them under constant review.

...better service

The advantages which the AD 2300 brings to the navigator, pilot and controller result in aircraft keeping more closely to their flight schedule and thus reducing frustrating and money wasting delays for the passenger, even when he is flying off the beaten track on routes where beacons and other ground based aids are few and far between.

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TOWARDS ASTRONAUTICS . . .

boundary layers and wakes. The N.A.C.A. has started experiments in these domains, and photographs have shown a plasma jet of ionized air, hotter than the surface of the sun, disintegrating a small aircraft model; and a model of an ion propulsion unit producing thrust by the acceleration of electrically-charged particles in a magnetic field. The principles of magnetohydrodynamics have been applied in the recently announced ZETA experiment for the controlled fusion reaction.

As aerodynamics has extended its scope to these very high Mach numbers, so the research tools and facilities have changed. Wind-tunnel designers have manfully kept up with the theoreticians and have produced astonishingly different designs for transonic, supersonic and hypersonic flow up to a Mach number of about 10. Shock tubes and shock tunnels, ballistic ranges and light gas guns extend the range to beyond M = 20. As the higher Mach numbers introduce intensive aerodynamic heating the aircraft structural engineer joins forces with the aerodynamicist in the provision of heating rigs consuming fabulous quantities of controllable electrical power.

Turning now to astronautics, and to some immediate targets [continued the lecturer], I want to concentrate attention on the more immediate future—say, the next ten years. It is clear that whatever the ultimate objectives of space-flight will be, a high priority must be first accorded to experiments measuring the physical, chemical and electrical properties of those regions of space extending a few thousand miles beyond the earth. The physicist and astronomer have depended on indirect methods of determining these quantities for several generations, but space-flight now gives the opportunity to make direct measurements.

The Russian sputniks have demonstrated that the two major problems of placing satellites in orbit have been solved, viz., propulsion to five miles per second and precise guidance. By

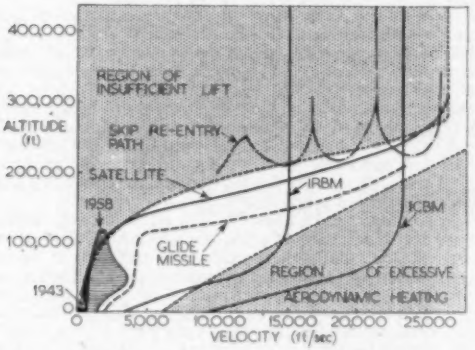

Fig. 2. The flight régime in which the vehicles listed in the table below operate is frequently referred to as the corridor of continuous flight into outer space. The "corridor" is the unshaded area of this graph.

extensions of the present techniques, such as better propellants, lighter structures, miniaturized guidance and control gear and bigger vehicles, larger-payload satellites may be expected, going to far greater distances than the first two. The Russians have officially announced their intention to fire objects to the surface of the moon, a task well within the reach of present technical capabilities. They have also spoken of sending transmitting laboratories to the surface of the moon. This would require substantial extra development, but it would not be surprising if it were done in the next few years.

The majority of experimental results can be obtained satisfactorily by telerecording, so the inability to recover after re-entry will not seriously hamper this work. It is inevitable that physical experiments will be succeeded by biological investigations prior to placing a man in and recovering him from a satellite orbit. This has not yet been achieved technically, and does present some difficulties which have yet to be overcome. Many methods for recoverable re-entry have been proposed and some of these are discussed next.

A satellite can be brought down by air drag. Sputnik 1 was highly unsatisfactory from this point of view and physicists, or more important, the occupant of a satellite, will require more-certain knowledge of which week he will return to earth and whether on a foreign mountainside or in a lonely polar sea.

There are three means of bringing a satellite out of orbit: (a) by retarding rocket impulse. This is extravagant in weight; (b) by air resistance. The drag can be increased either by variable conical skirt or by steel parachutes; and (c) by air lift. By this

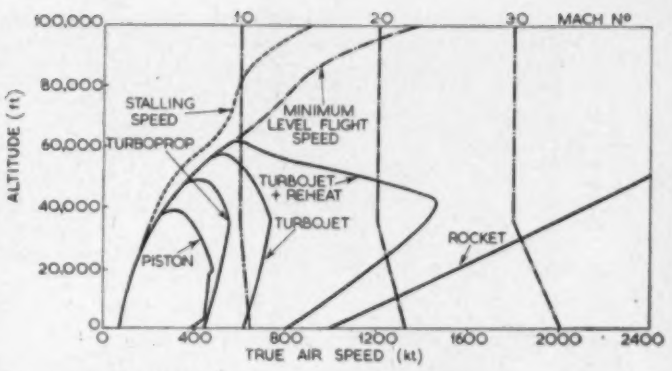

Fig. 1. Typical aircraft flight-envelopes, showing advances in performance from piston engine to rocket (from the historical review in the first section of Mr. Allen's paper).

means there is greater measure of control over the flight path, provided steps are taken to allow for severe heating effects.

Some project studies have already been made of devices employing lift during re-entry; some examples are described to indicate likely possibilities.

Krafft Ehricke, now of Convair Astronautics, proposed a five-man three-stage orbital glider in which the last stage had highly swept wing surfaces. It had a very low wing-loading of 11 lb/sq ft, and was estimated to be capable of descending from a satellite orbit and landing on retractable skids. Weighing about a million pounds, it represents an ambitious project unlikely to be built during the next ten years.

Dr. Ferri, of New York, prefers a boat-shaped configuration with highly rounded, swept leading "edges." The payload or crew space is in the lee of the forebody and re-entry is made in a series of skips. Heat generation during a pull-up is radiated away during the subsequent path in free space, and by this means the excessive weight of a heat sink is avoided.

Dr. Hilton, of A.W.A., considered the more severe case of re-entry from an interplanetary path at speeds greater than the orbital value, e.g., seven miles per second. In this case, considerable downward lift is required to curve the trajectory parallel to the earth. The associated high drag reduces velocity further, eventually to below the orbital value. The full brunt of the aerodynamic heating is taken on the flat pressure face which must be cooled or allowed partly to melt away. A near vacuum is formed on the lee side, which reduces heat transfer to the payload.

A period of experiment must be expected to elapse before the relative merits of rocket, drag or lift for re-entry from a satellite orbit can be assessed. The best solution may well combine the virtues of all three.

Future High-altitude Aerodynamic Research

Aeronautics and astronautics are about to embark on a most fascinating period of exploration of altitudes and speeds which have only been tentatively evaluated so far. We must be prepared for radically new shapes to appear. There will be a new emphasis on research and new experimental techniques. There is the ballistic missile with crucial or blunt nose re-entering at steep angle, the hypersonic aeroplane with highly swept and rounded leading edges cruising at above 100,000ft, and the hemispherical satellite coming in at low flight path angle to be recovered by parachute. These three representative configurations have quite different flight characteristics, as shown in the table [foot of this column].

Experience gained with the re-entry of ballistic missiles will not be wholly relevant to the hypersonic aircraft or the re-entering satellite, for both the angle of dive and the rate of heating are greater and the ballistic device does not require lift.

The flight regime in which these sort of vehicles operate is now

FLIGHT PATHS OF UPPER AIR VEHICLES

Class of vehicle	Altitude (ft)	Mach No.	Flight path angle (deg)	Aerodynamic heating effects	Duration
IRBM (1,500 n.m.)	200,000	15	38	800 kW/sq ft	(~15 sec)
ICBM (5,000 n.m.)	200,000	23	23	3,000 kW/sq ft	(~15 sec)
Hypersonic glider	120,000	5-10	near 0	5 kW/sq ft	(½-2 hr)
Re-entry from satellite orbit	250,000	20	0-10	High rates 100-1,000 kW/sq ft	(2-5 min)
Experimental vehicle	250,000	10-25	0-10	High rates 100-1,000 kW/sq ft	(2-3 min)

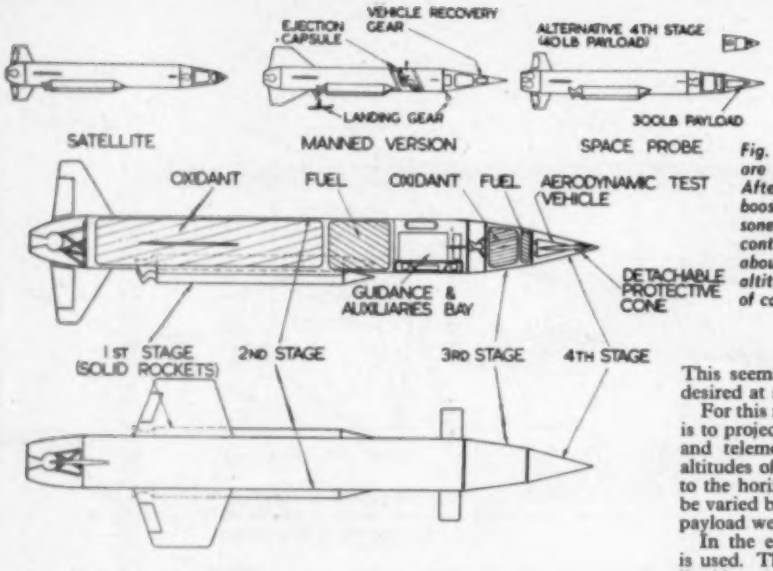

Fig. 3. Four-stage flight corridor research vehicle. Three stages are propelled by solid, liquid and liquid rockets respectively. After launch at about 35,000ft in a gentle climb, the solid boosters accelerate the vehicle to about Mach 2 and are jettisoned, possibly with some wing structure. The next stage, which contains the guidance and control equipment accelerates to about Mach 10 near 200,000ft. After a long coast to increase altitude the last propulsion stage is fired. The test vehicle is, of course, separated from the third propulsion stage for the sake of the experiment.

TOWARDS ASTRONAUTICS . . .

frequently referred to as the corridor of continuous flight into outer space. Fig. 2 shows this and compares the performance of 1943 and 1958 aircraft with the new regime which must soon be opened up.

In order to illustrate some of the performance possibilities in very high-speed, high-altitude flight in the flight corridor, I have selected a hypothetical aerodynamic experimental test vehicle which could be air-launched from a Vulcan (see heading picture on page 236).

Air-launching of experimental high-altitude vehicles is a well-known technique. The photograph (bottom of page 236) shows a recent N.A.C.A. test vehicle which is launched from a Martin B57A (American Canberra) at 45,000ft. It is a two-stage rocket which reaches a maximum Mach number of 10.5. Another application of the same concept was proposed by Robotti, a consultant of Fiat in 1956. A Convair F-102A carried a winged two-stage rocket built from V.2 components and a WAC Corporal. By flight refuelling and launching at 46,000ft, this test vehicle was estimated to attain a height of nearly 2,000,000ft.

For some experiments the attainment of high Mach number is the primary objective: for others, Mach number associated with a particular altitude is desired; and for physical experiments altitude, irrespective of speed, is the aim. Air-launching is also suitable for investigating an important class of re-entry flight paths from satellite orbits. These are characterized by flight-path angles less than, say, five degrees (rather than the 20-40 deg of ballistic rockets) and are associated with devices able to apply aerodynamic lift as well as drag in the control of their flight path. This seems to be essential if recovery of men or equipment is desired at some predetermined part of the globe.

For this reason the primary objective of the study I now propose is to project a 300 lb aerodynamic vehicle containing instruments and telemetry equipment to Mach numbers exceeding 15 at altitudes of the order of 400,000ft and at small flight-path angles to the horizontal. In any particular case, speed and altitude can be varied by choice of the initial climb path, and performance and payload weight can be exchanged.

In the example (Fig. 3) a four-stage rocket-propelled vehicle is used. Three of these stages are propelled by solid, liquid and liquid rockets respectively. After launch at about 35,000ft in a gentle climb, the solid boosters accelerate the vehicle to a Mach number of about 2 and are jettisoned, possibly with some wing structure. The next stage, which contains the guidance and control equipment, accelerates to a Mach number of about 10 near 200,000ft. After a long coast to increase altitude the last propulsion stage is fired. The test vehicle must obviously be separated from the third propulsion stage for the sake of the experiment.

This arrangement is not necessarily the optimum; advantage might be taken, for instance, of air-breathing accelerators for the first part of the trajectory, below about 90,000ft.

A vehicle of this type could fly other trajectories of current interest with alternative payloads. Farside (3 lb) and Vanguard (5 lb and 20 lb) suggest that the physicist can be satisfied with far smaller payloads than the aerodynamicist, and in such cases near-satellite performance should be possible. Alternatively, with a different wing, the vehicle could be flown more nearly vertically to place a payload of 300 lb near 400 miles altitude (with three stages) and 1,000 miles (with four stages). A smaller but still highly useful payload of 40 lb would, of course, go substantially higher. A manned version could assist aviation medicine experiments with a reduced performance.

No special merit is claimed for the air-launching technique. There are very many ways of going about this kind of experiment; some are cheaper than others, and some offer more flexibility. As an indication of the immense possibilities for the immediate future, over 250 projects have been submitted to the U.S. authorities for vehicles to operate beyond the atmosphere. This country, however, need not produce a rash of such projects, but I really do think we should be getting on with one or perhaps two of them.

P.181 and 182 (continued from page 235)

accessory box drives the pressure and scavenge oil pumps, fuel pump and percentage gas-generator tachometer, and also transmits the drive from the starter motor (electric, i.p.n. or pneumatic) which is mounted on the starboard side. From the rear of the accessory gearbox a drive shaft can be extended to a remote box mounted on the airframe.

Single-lever control is provided for the all-speed-governed fuel system, which has been designed to permit the use of any normal gas-turbine fuel (including, in emergency, petrol). Two engine-mounted levers are fitted to govern the speed of the gas generator and power section. The first operates the throttle and h-p. shut-off cock and the second combines the selection of propeller speed, feathering and application of the parking brake. The propeller r.p.m. can be varied quite widely without incurring a marked penalty in specific consumption, but Armstrong Siddeley suggest that the power turbine be held at 85 per cent of maximum r.p.m. Air-bleed and electric anti-icing systems are incorporated, and the compressor is surrounded by an annulus incorporating air tapping points for all normal bleed purposes.

It is worth laying special emphasis upon the efforts made by Armstrong Siddeley to increase the reliability and inbuilt safety of the engine. In any free-turbine engine, mechanical failure—such as stripping of the input gear to the propeller—can lead to sudden and catastrophic runaway of the power turbine, and in the P.182 a unique arrangement is incorporated to cut off the fuel should the r.p.m. of this section increase beyond a given limit. The basic layout of the engine places at least three layers of heat-resistant steel around the turbine section; moreover, the peripheral rings which preserve the outer profile of the gas path around the turbine rotors are themselves strong enough to contain any blade failure which could occur. In the delivery volute from the centrifugal compressor the diffuser cascades have stainless-steel leading edges, and each vane overlaps its neighbours to cut off any line-of-sight path which could be followed by foreign bodies entering the engine. Containment of the axial compressor rotors is ensured by steel bands inserted into the stator casing around each rotor stage.

Virtually all the foregoing applies also to the P.181 helicopter engine. This unit will be available in either forward-drive or rear-drive versions, and is being designed for omni-angle installation. In the front-drive version the reduction gear is mounted in the intake centre-body, and in the alternative arrangement the complete gearbox is suspended in the centre of the single or bifurcated exhaust duct by means of a lightweight structure.

ARMSTRONG SIDDELEY P.182

Free-turbine turboprop for fixed-wing aircraft, with two-stage axial compressor followed by a centrifugal compressor mounted on the same shaft and driven by a two-stage turbine, the propeller being driven by an independent single-stage power turbine.

Overall length from propeller-cone abuttment line to rear face of exhaust cone, 59.975in; approximate overall length including spinner, 89in; maximum overall diameter (over compressor stator casing and combustion-chamber joint flange), 27.3in; equipped dry weight, approximately 600 lb; maximum compressor speed, 20,000 r.p.m.; maximum power-turbine speed, 14,600 r.p.m.; maximum mass flow, 12.5 lb/sec.

P.181 turboshaft engine for helicopters, generally similar except for the following particulars: overall length as shown in the photograph, 63.675in (including 6 kW generator); equipped dry weight, approximately 540 lb.

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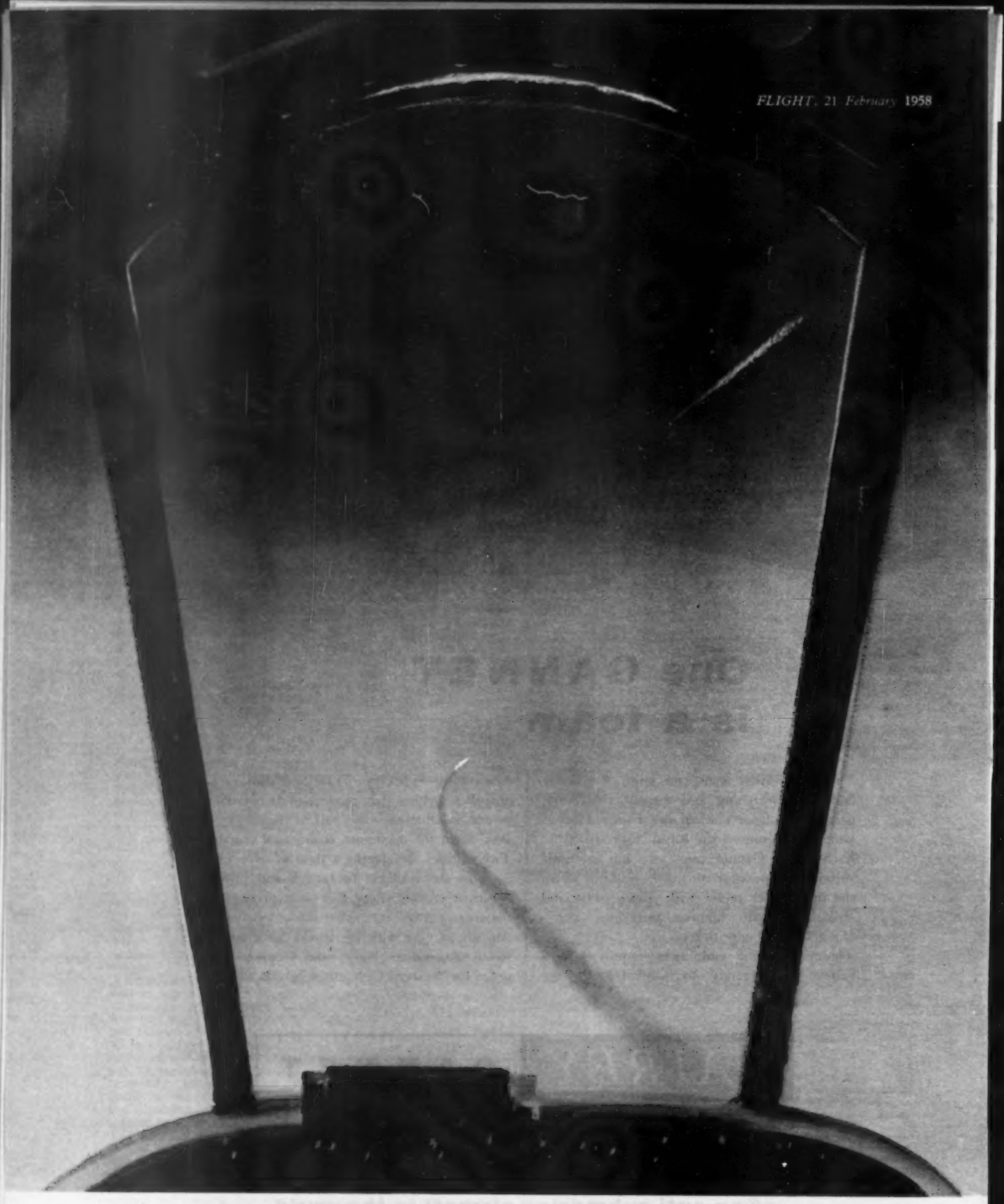

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Fighter Design Philosophy

A Designer's Appraisal

By R. F. CREASEY, B.Sc.

ALMOST the only statement that can be made with assurance on the subject of missiles displacing fighters is that nothing drastic is going to happen overnight; even intercepter fighters will be with us for many years to come. In this article the deputy chief engineer of the English Electric Company's aircraft division examines target-defence against manned bombers and discusses some of the variables affecting the design of a fighter.

THOUGH it once appeared that the long history of the fighter would come to an end soon after defensive guided weapons had been developed, further reflection suggests that the fighter will have an important part to play so long as there are bombers or reconnaissance aircraft to intercept. For this purpose the manned aircraft must be properly combined with the guided weapon.

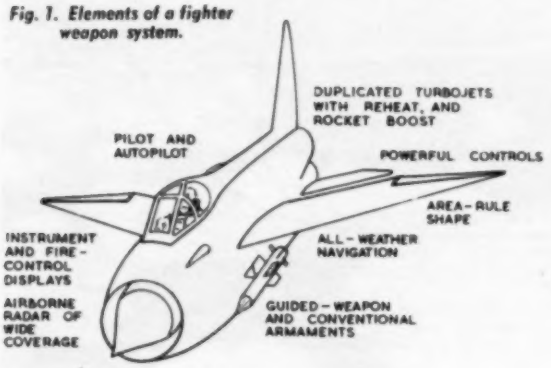
It is difficult to imagine defensive guided missiles undertaking a semi-offensive tactical rôle comparable with that of the fighter in all situations up to and including Korea, Suez and Oman. Offensive missiles can threaten only well-established targets, and then mainly by resort to warheads that would also destroy civilization. The ability of the manned aircraft to fly in and intercept, or to reconnoitre and strike at small targets, underlines its value in situations that have actually occurred, as well as in any ultimate conflict. The design of fighters must change radically, however, and a change is already apparent in such aircraft as the English Electric P.1B with its Ferranti fire-control system and radar.

THE WEAPON SYSTEM. An illustration of a modern fighter is given by Fig. 1. That the fighter is now considered as a complete weapon system is a change in tradition as much as in technical detail. It was usual at one time for the fighter designer to concern himself only with airframe design. It is true that he always expected the engine designer to ensure that maximum performance was being extracted, but his primary concern with equipment and armament was to ensure that it could be installed inside the airframe. This was in an era when the superiority of a fighter was measured largely in terms of miles per hour or ceiling. Performance in this sense is still important, although it now has much more complex definitions in terms of the ability to climb, accelerate and turn into positions to launch small missiles.

Rocket-propelled Missiles are the main reason for a change in philosophy. Small airborne missiles have much more speed and manœuvrability than the fighter, and this enables them to complete the last part of an interception with greater economy. Although this is true only up to the limits of guidance and reliability, it can be made sufficient for the last few miles of an interception against almost anything a bomber can do. A rocket-propelled weapon can climb so steeply that it can be launched ten or twenty thousand feet below the bomber at the expense of a small increase in the size of missile. This does, however, allow a very large reduction in the size of the fighter and thereby in the overall cost. This cost is still the lowest for many tasks since the most expensive component (i.e., the fighter) is not expendable and can destroy a number of targets in successive sorties.

Airborne Radar is another reason for a change in design philosophy. This is due to the fact that high-altitude combat involves distances to accelerate or turn which are often too great for manœuvring up to the final interception point with human eyes alone. Ground-based radar has neither the accuracy nor capacity for this purpose, particularly in the presence of enemy jamming.

Fig. 1. Elements of a fighter weapon system.



Airborne radar is now a well-developed method for augmenting the pilot's vision and may itself be augmented by infra-red techniques. But unless the equipment is designed in parallel with a high-performance aircraft one is liable to end up either with equipment which itself is outclassed by the enemy or with no equipment ready at all. This does not prohibit the use of the same equipment in aircraft with less rigorous requirements, or its development for use in later aircraft.

All-weather Fighters used to be much larger than daylight fighters of equal performance, due to the extra equipment required to operate at night or in bad weather. But the major item of equipment is now required in daylight, if we accept radar as a necessary adjunct at high altitude. Since an enemy is likely to use modern navigational aids in order to attack by night or in bad weather, it seems useless to spend much of our future effort or exchequer on the day fighter. Accurate navigation and blind-approach aids are other items required for all-weather operation. Development of these has now reached the stage where they can be made small and semi-automatic for the use of the pilot.

These are not the only ways in which the advances in electronics and servo systems required for the guided-missile industry can be utilized to improve the fighter itself. There is no reason why a large part of the all-weather fighter force should not be single-seaters, with an autopilot to fly the aircraft whilst the pilot is concentrating on his radar screen.

Man himself seems essential for the latter task and any setback in electronic warfare could well restore the case for a second crew-member. A balanced solution might rely on electronics and other automatic aids up to the point where each man can carry out his functions with sufficient time to cope with emergencies brought on by malfunctioning of some part of his equipment. The reliability of much of this equipment seems to be approaching the stage where it can be developed to work 90 per cent of the time, but the remaining 10 per cent must not be allowed to abort the interception.

Ground-launched Guided Missiles already have more than sufficient range to replace the heavy anti-aircraft gun. These can provide protection to key targets as a supplement to the broader cover offered by the fighter. Weapons like the English Electric Thunderbird are inevitably much larger than airborne missiles but much smaller than a fighter. Their development provides some hope for the interception of high-performance missiles. If these are launched from a bomber, however, it would be more satisfactory to shoot down the bomber itself before it came in close enough to release its powered missiles.

This still appears to be the task of the fighter. Guided weapons with an interception range of some hundreds of miles seem to rely on so many components to complete their interception that the various percentages of unreliability soon add up to make the interception more a matter of chance than anything else. Furthermore, the size of the weapon eventually grows to the point where it becomes too expensive to be thrown away on every test flight or to be destroyed completely after each interception. It will then pay economically, as well as in reliability, to make it large enough to carry a crew to ensure its recovery after each flight and to carry a number of smaller but more manœuvrable missiles to destroy a variety of targets. The presence of the crew to interpret the airborne radar also provides accurate guidance at much greater distances from the ground radar.

The presence of a crew throughout the flight-test development and operational periods reduces the time taken to develop or adapt the system to meet technical advances which the enemy might make. This is most important now that it takes so many years to develop any new system.

In guided-missile jargon this long-range intercepter might be described as a two-stage weapon. The man in the first stage is provided with approximate mid-course guidance from ground radar and airborne navigation, but with accurate terminal guidance from airborne radar. The smaller second-stage weapons can have guidance provided either from the first stage (beam-riding) or partly from the first stage (semi-active radar) or be completely self-contained (fully-active radar or passive homing with infra-red). Simplest of all, the weapons need have no guidance

FIGHTER DESIGN PHILOSOPHY . . .

except that provided at launch by the airborne radar, or by visual sighting.

The first stage can still be recognized as a modern form of fighter. At the present time it must still have sufficient performance and manœuvrability to get into position to use unguided armaments, such as guns and rockets, or guided armaments like those now entering service. As soon as we can rely on more advanced guided missiles for the second stage the fighter will degenerate into a guided-missile platform, carrying precision airborne radar. The mobility of this platform in terms of interception distance, reinforcement, airfield diversion, patrol endurance and ability to get into position to use airborne radar and launch weapons will be of great importance; but developments in airborne radar and missiles will make it less necessary to compete with further improvements in the performance of the bomber.

TYPICAL INTERCEPTIONS. As broad statements of philosophy are best illustrated by examples, let us assume that modern fighters are stationed ready to intercept an attack by day or night. It should be possible to base these fighters on widely spaced airfields in countries where cities and other targets are well scattered. The ability of the fighter to move from one airfield to another enables the defences to be switched or reinforced in accordance with the tactical situation. This flexibility avoids the danger of a Maginot Line type of defence which can be punctured, turned or even avoided altogether. The value of more-static defences is to defend key targets, and this is where ground-launched guided weapons play a vital rôle. A simple diagrammatic picture of the situation is given in Fig. 2.

Early Warning Radar is required with any defensive system to give the maximum possible warning of attack and while the bombers are still at a sufficient distance from their targets. Unlike present forms of ground-launched weapons, fighters have sufficient endurance and long-range guidance to be despatched as soon as the threat has been confirmed. In a confused battle with many attacks, and even with jammed ground radar as well, the fighter can deal with the situation from the air. It is possible for the enemy to jam a number of ground radar stations, but virtually impossible for him to deal with a whole series of fighters each carrying its own radar "station."

Proper airborne radar can reduce the task of the ground radar merely to approximate positioning of the fighter on initial compass headings or course corrections. This is most important, as ground radar is notoriously easy to jam and gives far less accurate results than precision radar which is airborne nearer the target.

The fighter can take off and climb up to its cruising altitude in two or three minutes. Directions from the ground radar may be in the form of an elaborate radio link with the controls of the aircraft, but the fighter pilot always retains the ability to fall back on simple voice communication as he did so effectively in the last war. This system is imperative in confused situations where any part of the automatic system has broken down or has been interfered with.

While the fighter is many miles from its target, its own radar scanner is searching to and fro over a large area of sky. Information is presented on the pilot's screen and this increases his effective vision by very many times. Even with chance encounters a proper airborne radar should enable the pilot to locate a target whilst he still has sufficient distance to manœuvre into position to use his weapons. With the rate of climb and dive of our modern fighter, this is true even if the target is at a very different altitude from the fighter.

The Turn to Attack can begin as soon as the pilot identifies a target on the radar screen. The radar instrumentation is arranged to supply information on the course to steer so as to reach the best position for launching the weapons against the target. There are a number of ways of doing this, of which the most sophisticated is to stop the radar scanner from wagging and leave it pointing directly at the target. A servo system is then used to "lock" the scanner so as to follow the direction of the target. The angular positions of the scanner, and possibly range information from the radar, are then fed into a computer which provides the course to steer, either through the pilot's instruments or possibly through the autopilot as well.

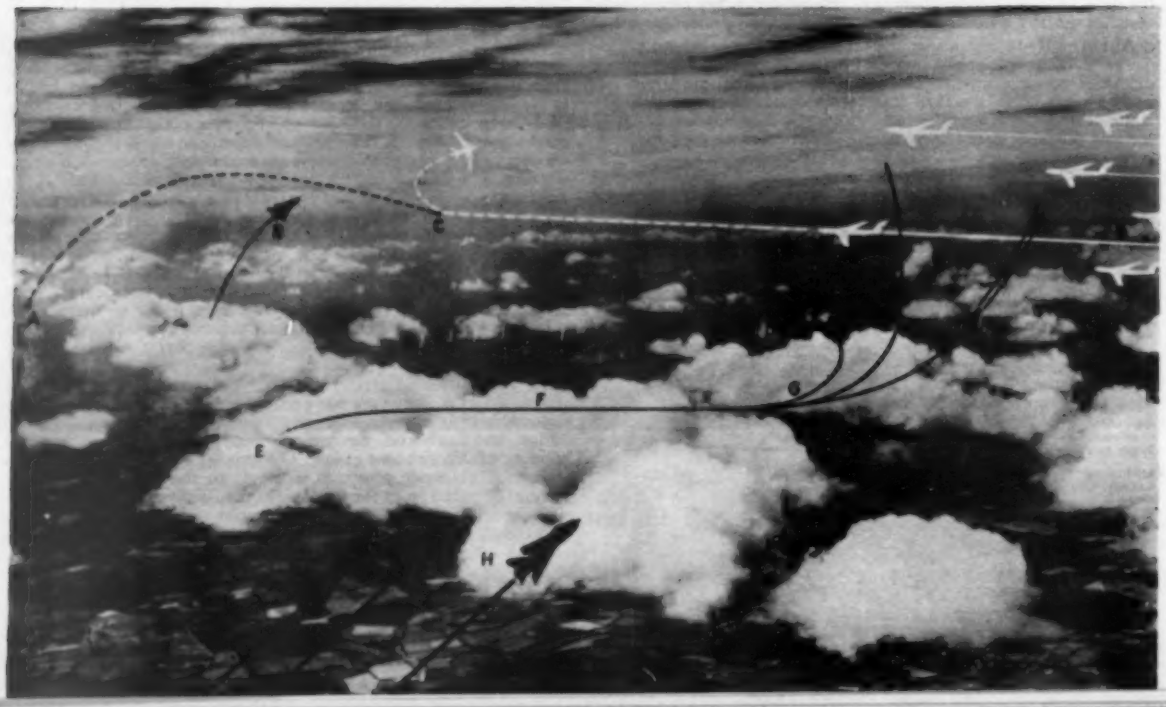
To be successful, the system should take account of any limitations on performance or manœuvrability of the fighter, together with possible evasive action on the part of the target. Extremely complicated mathematical equations can be derived for the optimum course, but it is usually better to approximate this course so as to simplify the computer and instrumentation. It must end at a position from which the weapons can be fired successfully, taking account of any limitation on performance or manœuvrability of the missile.

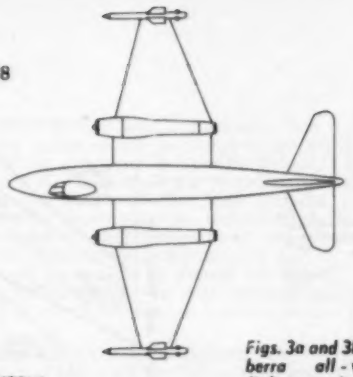
Weapon aiming with unguided shells or rockets must obviously be accurate, pointing ahead of the target with just sufficient "lead" angle to collide with it. This computing is at present carried out in the highly ingenious but simple mechanism of the gyro gun-sight.

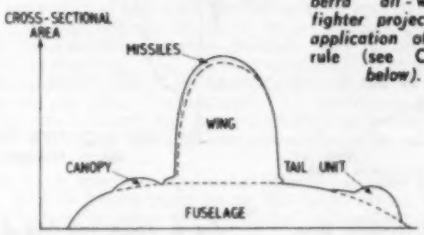
Less accurate aim should be necessary with guided missiles, because they can manœuvre and guide themselves. They can thus be designed for less complicated computing than is required for firing guns and unguided rockets. There is, however, a temptation to make use of modern electronics to the extent that, once the pilot has carried out his essential function of identifying and marking the target, he can sit back and let the autopilot fly the fighter into the optimum position from which the weapons are fired automatically. However near one approaches complete automation, full use is not being made of the man in the aircraft unless the design of the system is such that its partial or even complete failure would not prevent the pilot from completing his mission on simple instruments or even visual sighting.

With a beam-riding weapon, it is necessary for the fighter to aim accurately at the target right up to detonation of the warhead.

Fig. 2. This illustration portrays the major elements in a hypothetical target-defence situation, with missile-firing fighters engaging piloted bomber aircraft: A, intended guided-weapon target for main bomber attack; B, rocket-boosted fighter; C, intended release-point of powered bomb; D, bombers detected by ground radar over own territory; E, fighter airfield; F, fighters' cruise-out under approximate ground guidance; G, identification of bomber force by airborne radar; H, long-range reinforcement fighters.







Figs. 3a and 3b. Canberra all-weather fighter project, and application of area rule (see Col. 2 below).

With semi-active weapons (e.g., some versions of Falcon and Sparrow), in which the larger airborne radar transmits the signal and the weapon receives the echo from the target, it is only necessary for the fighter not to turn away so rapidly after firing its weapon that its airborne radar loses effective sight of the target.

But with unguided weapons (e.g., guns or rockets), homing weapons (e.g., infra-red weapons like the D.H. Firestreak) or fully active weapons with their own radar transmitter (e.g., Vickers Red Dean), the fighter can turn away as sharply as it likes. Unguided weapons follow an approximately straight path for only a very short distance, as they follow a ballistic path with appreciable aerodynamic dispersion. To ensure vital hits on the target it is usually necessary to aim a large number of missiles in a rapid burst at short range, but this situation can be improved considerably by using more powerful rockets and warheads.

Weapon Guidance will also reduce the number of missiles required to destroy a target. The navigation system of these guided weapons is usually such that, after launching, the missile turns rapidly on to the collision course which should meet the target. Unless the target manœuvres rapidly, this course is almost straight, but the missile should always pass very close to the target if a number of conditions are satisfied:—

(a) The guidance system is properly designed and aims continuously near the vital area of the target, e.g., an infra-red system homing on major heat-sources in the central area.

(b) The missile is able to respond rapidly so as to reduce the terminal errors. This can always be obtained with a small missile and a properly designed control system.

(c) The missile has sufficient manœuvrability to turn on the path dictated by initial aiming errors or by evasive manœuvres of the target. The wing size required to satisfy this is a small fraction of that required to bring the complete fighter or ground-launched missile up to the same altitude.

(d) The missile has sufficient performance to reach the target. Even if the target is at very high altitude, the size of the rocket motor required to meet this case is again a small fraction of that required to bring the complete fighter or ground launched missile up to the same altitude.

(e) All components of the missile should function reliably throughout its flight. Due to the shorter flight under its own power and simpler conditions, this requirement is much more easily met than on ground-launched weapons.

Nevertheless, (e) is still a difficult condition to satisfy, and there is always a chance that the proximity or contact fuse will not set off the warhead at sufficiently close range to destroy the target. More than one guided weapon must therefore be carried if we are to have an effective fighter weapon sytstem. An additional safeguard is to supplement the guided weapons by other weapons, which would certainly be adequate to finish off a crippled target or to allow attacks on different targets. Until the practical service reliability of guided weapons has been thoroughly assessed, the safest policy is to carry as many different armaments as possible or to make them quickly interchangeable on the ground. This policy will always be necessary to some degree to cater for possible target countermeasures.

Ground-launched Weapons may be considered to supplement the fighter. Even with fighter-weapon systems designed as discussed above there is obviously some chance of occasional bombers slipping past the first wave of interception. This chance is clearly reduced by having sufficient fighters in the defensive system to ensure that the enemy is always outnumbered. This requirement is easier to satisfy if the fighter has sufficient range to reinforce the battle from some less-threatened sector.

Where special ground targets are of sufficient importance to warrant expenditure on localized defences, it will pay to ring these with ground-launched weapons. These are now sufficiently advanced in development to supersede the manned rocket fighter as originally used in Germany for this purpose. (The value of rocket boost for high-altitude interceptions is, however, discussed later in this article.) A shortcoming of these weapons is that they cannot join the battle very far from their base. They are therefore of restricted use against the bomber which can drop glide-bombs or powered bombs at a considerable distance from the target, or against the enemy's radar-jamming aircraft lurking at long range.

It is on these and similar grounds that, so long as there are bombers or other aircraft to intercept, the case for the modern fighter will remain. The best division of expenditure between fighters and guided weapons depends on geography and the nature of the threat, but it is still possible to visualize situations where the case for the fighter remains nearly 100 per cent.

PERFORMANCE PHILOSOPHY. As soon as we can rely on small airborne missiles to complete the interception under all conditions, then we can accept a complete change in philosophy as to the performance of the fighter. It will no longer be necessary for the fighter to have speed and altitude supremacy over all possible targets, but only sufficient overall performance and manœuvrability to get into position to use its airborne radar and then to launch its missiles.

Subsonic fighter experience provides an illustration of the future problems of intercepting bombers with similar performance to the fighter. This has required the fitting of sophisticated radar and missiles, and these have been of such dimensions as to require aircraft of Canberra size to make a useful weapon system (Fig. 3a).

Fixed forward-firing guns are of value only if the fighter has sufficient speed to allow it to manœuvre quickly into the pursuit position, closing up from the stern of the target. Similar requirements apply to many of the present forms of guided weapons, as the main advantage of these should come in terms of lethality only after they have been launched from the correct position. The fighter must therefore continue to have a large speed superiority until even more sophisticated weapons have been brought into service, and these will still require the fighter to have an approach speed that is a high percentage of that of the bomber. Since bomber speeds have generally increased to near the speed of sound, with the prospect of more at supersonic speeds, this means that future fighters must have substantial supersonic performance, and that this requirement will continue. This needs very careful definition, and certainly requires economical solution of most of the problems associated with the so-called "sound barrier." It means that aircraft like the Canberra are no longer of interest as fighters, even though they continue to be of value in many other rôles.

The "Sound Barrier" has proved a true barrier to many modern fighters, and this can be explained by reference to the Area Rule. At transonic speeds one merely needs to measure up the cross-sectional areas of the aircraft and plot these as shown for the Canberra in Fig. 3b. This simple form of Area Rule suggests that the wave drag at near $M=1$ will be similar to that of a body of revolution having cross-sectional areas equal to the total shown. Even a body of smooth shape will have an appreciable drag rise up to $M=1$, but the large bulges representing the unswept wings, engine nacelles, missiles and tail surfaces give the Canberra a prohibitive drag-rise for efficient supersonic flight. Moreover, it is of little value to try to boost such an aircraft with rockets, as not only is the fuel consumption prohibitive but the buffeting, wing dropping and other trim changes make an aircraft disobeying the Area Rule of little value at transonic speeds. It is theoretically possible to reduce the transonic drag of the Canberra by the addition of fuselage bulges fore and aft of the wing, similar in principle to that tried on current fighters. This gives a small reduction of drag in practice, but it is doubtful whether the complication or weight penalty of the fairings is justified.

The direct method of reducing these problems is to cut down the cross-sectional areas, e.g., by using wing and tail surfaces of less span and thickness. This has been done in a number of current aircraft, but unless the full implications of the transonic Area Rule are used (e.g., very large sweepback) the net result is only to eliminate most of the useful space in the aircraft and to give thrust and drag curves which at best resemble those of Fig. 4. Even though these result in appreciable supersonic performance, there will be insufficient margin for practical interception.

Supersonic Performance Margins are now essential for a fighter, as it is of little use to reduce supersonic drag to the point where it is only slightly less than the thrust from all the engines (plus reheat) that can be crammed into the aircraft. Although this can give Mach numbers as high as 2 or more on paper, these can be demonstrated only by flights in unrepresentative conditions. Reheat behaves very much like a ramjet at these speeds and

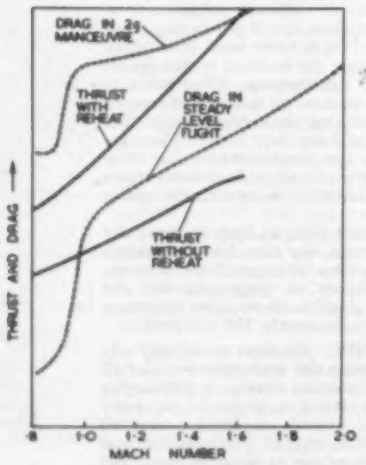


Fig. 4. Thrust and drag for a fighter without high sweepback.

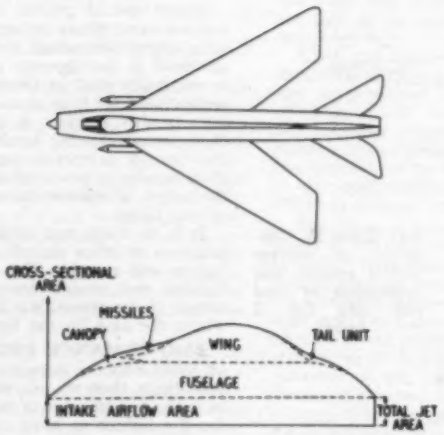


Fig. 5. Fighter designed on basis of transonic Area Rule for minimum wave-drag.

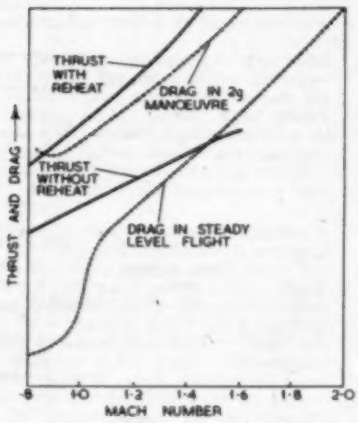


Fig. 6. Thrust and drag of Area Rule fighter (such as that in Fig. 5).

FIGHTER DESIGN PHILOSOPHY . . .

can give most impressive performances and altitudes, but the aircraft is of little practical use as a supersonic fighter if it cannot reach these speeds and altitudes very quickly in interception manœuvres, carrying all the operational loads required on the inside and outside of the aircraft. Economical cruising is best carried out at high subsonic speeds and moderate altitude until such time that a target is finally identified. A fighter with poor acceleration and climb-away from this condition is in danger of failing to reach combat speed and altitude in time to make an interception. The large increase in drag due to any necessary manœuvres in this period (Fig. 4) will delay the build-up of interception speed and altitude for a considerable time. This not only gives the bomber time to launch its bomb, but the fuel consumption of an engine with considerable reheat will eat into the fuel reserves required for a safe return to base under adverse conditions.

Fig. 4 shows that such a fighter relies completely on reheat for its supersonic performance. If the reheat system should misbehave, through lack of oxygen or for other reasons, it will never complete the interception at all. Moreover, if this fighter cruises at supersonic speeds in order to make the interception more practical, the large amount of reheat required to maintain level flight will re-double the fuel consumption, which is already much higher than in economical low-drag conditions at subsonic speeds.

The net result is to give a supersonic performance of doubtful value for interceptions, at the expense of much of the useful space inside the fighter. If a larger weapon system has to be added to the aircraft, the extra weight and drag can eliminate transonic performance altogether. This is particularly true in warm air, which reduces the engine thrust below the values quoted in standard conditions.

Area Rule Design is therefore important if we are to obtain sufficient margin of thrust over drag for practical interceptions. The highly swept wing illustrated in Fig. 5 is seen to spread its volume thinly and smoothly over the long length of centre fuselage, which is designed with approximately constant cross-section. Any shaping of the fuselage is thereby confined fore and aft of the wing, in conformity with the Area Rule. Local adjustments of this shaping are made at the front to fit in the necessary vision for the missiles and pilot, and similarly towards the rear for the tail surfaces. It is possible to stagger two engines one partly behind the other in the long constant section of fuselage, thereby reducing the cross-sectional area and drag. This also increases the cross-sectional area of air entering the intake, which can be deducted from the total areas when considering the Area Rule (Fig. 5).

It is then possible to arrive at a practical fighter which not only has the highest possible thrust/drag at supersonic speeds, but which maintains its superiority up to Mach numbers of about 2. This can be shown by application of the more complicated forms of Area Rule at higher Mach numbers. The resulting improvements in thrust/drag relationship are illustrated in Fig. 6. It will be noted that the increase in drag in manœuvring flight is also reduced at subsonic and moderate transonic speeds. This is due to the development of an aerodynamic thrust on the leading edge of highly swept wings, provided the tip sections are properly rounded over the leading edge.

The net result is to help overcome all the interception problems discussed above. The aircraft is capable of cruising economically at moderately high supersonic speeds without using reheat. The use of reheat then gives a very large increase in the rate of acceleration and climb from low supersonic speeds and allows speed and height to be maintained in significant manœuvres.

Highly swept wings and tail surfaces give the best compromise for a modern fighter (Fig. 5), due to this emphasis on performance over a range of speeds, particularly moderate supersonic speeds. Experience has shown that such an aircraft, designed to the Area Rule from the start, can avoid buffet, wing-drop and other trim changes, provided the necessary care is taken in the wind-tunnel test programme and in the details of the control system.

The Thermal Thicket. What has been termed the thermal thicket is now of some significance, for use of reheat makes it easy to reach Mach numbers of 2 or more. The pilot certainly needs refrigerated air, but much of the temperature-sensitive equipment and electronics can be situated either in the cabin itself or in compartments which receive the cooled air discharged from the cabin. Light-alloy structures can be made sufficient for Mach numbers up to at least 2, provided a little titanium or steel is used around the engine and jet-pipe sections.

It would seem pointless to penetrate farther into the thermal thicket, where airframe and engine problems become much more severe, as it is doubtful whether a fighter has sufficient time or fuel to make much practical use of these speeds. If bomber performance should penetrate the thermal thicket it will be possible to obtain the increase in interception performance from small missiles, which require a much smaller amount of fuel to boost them quickly to the required performance. The thermal problems of the missile will, of course, have to be solved, but these are again on a much smaller scale than they are on a complete fighter and are very much eased by the limited flight-time of an air-launched missile.

Rocket Boost can give a large increase in thrust at relatively light weight, but the total fuel consumption is many times that of a turbojet. The net result is compared in a general way on Fig. 7, where it is seen that the rocket gives a lighter gross weight when a burst of thrust is required for a very short period. This period is too short for the rocket to be of practical value to the fighter at normal altitudes, where the latter is already capable of extremely high performance with turbojets and reheat. This allows high speed to be obtained quickly and more economically at medium altitude, so that the very high kinetic energy can be converted quickly into 30,000ft or more additional altitude in a "zoom" climb.

Although we rely on turbojets as the primary fighter propulsion, a small proportion of exceptionally high targets may necessitate the addition of small rockets and fuel to maintain interception speeds at very high altitudes. The effectiveness of this combination up to above 70,000ft was demonstrated recently by the record-breaking Canberra fitted with a Napier Double Scorpion rocket. This engine is designed for the P.1B as an additional powerplant, which can be quickly removed if operation at very high altitudes is not required.

The flight time of the air-launched missile is, however, so short that it is always best to use rocket propulsion, regardless of altitude. It is also much more economical to boost a small airborne missile to much higher speeds and altitudes than to boost

a complete aircraft or ground-launched missile. This is why we aim to rely on the rocket missile to complete the interception, particularly at altitudes well above those of the fighter.

We must still rely on the turbojet for propelling the fighter at low and medium altitudes, while for high altitudes we have recently had impressive demonstrations—notably by the Canberra fitted with the Napier Double Scorpion—of the advantage of adding small rocket engines to turbojet-powered aircraft. But we certainly cannot rely on the use of rockets for take-off, balked landing or other emergencies, as the fuel reserves required will leave an impractical margin for combat manœuvres with present weapons.

EMPHASIS ON SAFETY AND ECONOMY. In this era of guided weapons and anticipated failure-rates, it is important to remember that there are still men in the main fighter components. In spite of the difficulties, we must therefore make the standards of safety as high as ever. The importance of this is also emphasized by the growth in cost of the complete weapon system, which means that we can afford fewer aircraft on a peace-time budget. We must therefore ensure that peace-time training wastage plus more rapid operational wastage does not eliminate the effective fighter force.

Controls in all practical supersonic fighters are now power-operated. This is forced upon us by the large, erratic hinge-moments which occur across the speed of sound, making normal muscular efforts quite inadequate. Truly irreversible operation is also necessary to prevent flutter, or slower oscillations such as snaking and hunting. The mechanical reliability of these systems must, however, be developed to a very high standard by exhaustive testing on the ground, and the complete system must be duplicated in the aircraft. This must extend right through to the basic power supply. Although windmills [ram-air turbines] and accumulators are useful adjuncts, the only way of ensuring complete control up to touch-down is to have two or more engines.

Twin turbojet engines are the most economical solution to this requirement for duplication. This not only allows a high thrust/drag ratio, with all the advantages previously discussed, but is a safeguard against the complete loss of propulsion. This is a serious emergency for the modern fighter pilot, as the resulting rate of descent of a supersonic aircraft is many times that catered for on the undercarriage, and any ability to flare out may be prejudiced by the above limits on control at the critical time. Although an experienced test pilot may sometimes prove adept at landing a "flying brick" on to a long runway that he has kept conveniently close, it is a different matter for the average Service pilot under practical conditions or in bad weather, and he would be prudent to use his ejector seat even though this would mean complete loss of the aircraft.

But if we say that the chance of an engine failing is one in a thousand, then the chance of two engines failing in the same flight is at least one in a million, when allowance is made for the fact that this engine can be "nursed" on an emergency return to base. This assumes that each engine has more than sufficient thrust for the purpose, as is the case for two large turbojets in an aircraft like the P.1. By installing both engines in the fuselage we also eliminate the asymmetric-design case for rudder and ailerons following the failure of one engine.

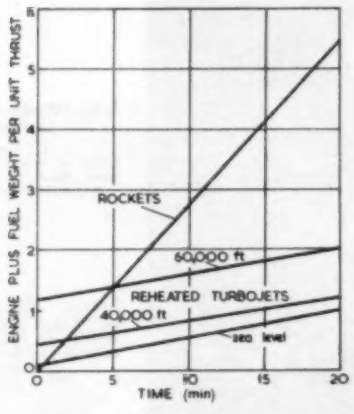


Fig. 7. Comparison of gross weight of engines plus fuel.

Tailplane Control is required to give adequate manœuvrability for supersonic interceptions. The use of elevons or foreplane will trim less than half the available lift from the wing under some conditions of flight, whereas an all-moving tailplane can trim all the lift available up to the buffet limit at low speeds and the directional stability or other limits at high speeds. It also allows trailing-edge flaps to be trimmed out, with consequent improvement in airfield performance. A delta wing plan-form also gives a good compromise between airfield and supersonic performance. If the fuselage is not long enough to give sufficient tail-arm the delta plan-form can be modified as on the P.1.

Carefully designed slotted flaps can give nearly the same lift as does blowing over the flaps with air ducted off the engine compressor. The latter can be made safe during the final approach only if the system is fully duplicated from two engines.

Inherent Stability is possible only if care is taken in the location of this tailplane. Low-aspect-ratio wings deflect the airflow downward behind them by more than half the angle of incidence of the wing. Provided this downwash/incidence relation remains constant, the effect on stability can be compensated by a more forward centre of gravity, without loss in the manœuvring power of the tail. However, beyond the incidence at which a complicated vortex-wake system forms behind the wing, body and intakes, the downwash near the centre line (i.e., over the tailplane) can increase rapidly to as much as the incidence of the wing (Fig. 8). If the aircraft is trimmed to these incidences, the loads on the tail are such that all stability is lost abruptly and the aircraft "pitches" up to a higher incidence with serious effects on structural loads or on the stalling of the wing and intake.

Fortunately, it was found from wind-tunnel tests that if the tailplane is situated substantially below the vortex wake system the downwash decreases rather than increases, giving a strongly stabilizing correction even if the aircraft should inadvertently be pitched to high incidence. This stabilizing effect can, in fact, be so powerful as to seriously restrict the incidence that can be trimmed. This effect can be prevented, as on the P.1, by giving the wing just sufficient sweepback so that the unstable pitching moments caused on the wing by the vortex system just balance out the effects on the tail. The tailplane should, however, be kept below the plane of the wing if it is to be clear of wake disturbances under all conditions of flight.

Auto-stabilization might seem a satisfactory method of curing such unstable flight conditions, but these devices either limit the operational use compared to an inherently stable aircraft, or else become quite complicated and therefore liable to failure. Electrical signalling in the basic stability of the aircraft having once been accepted, arguments can soon be made in favour of electrical signalling to replace the mechanical linkage between the pilot's stick and the controls. But our present experience suggests that the electrical parts of the system will need to be at least triplicated

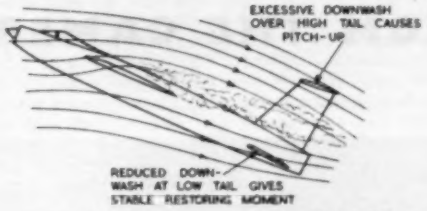


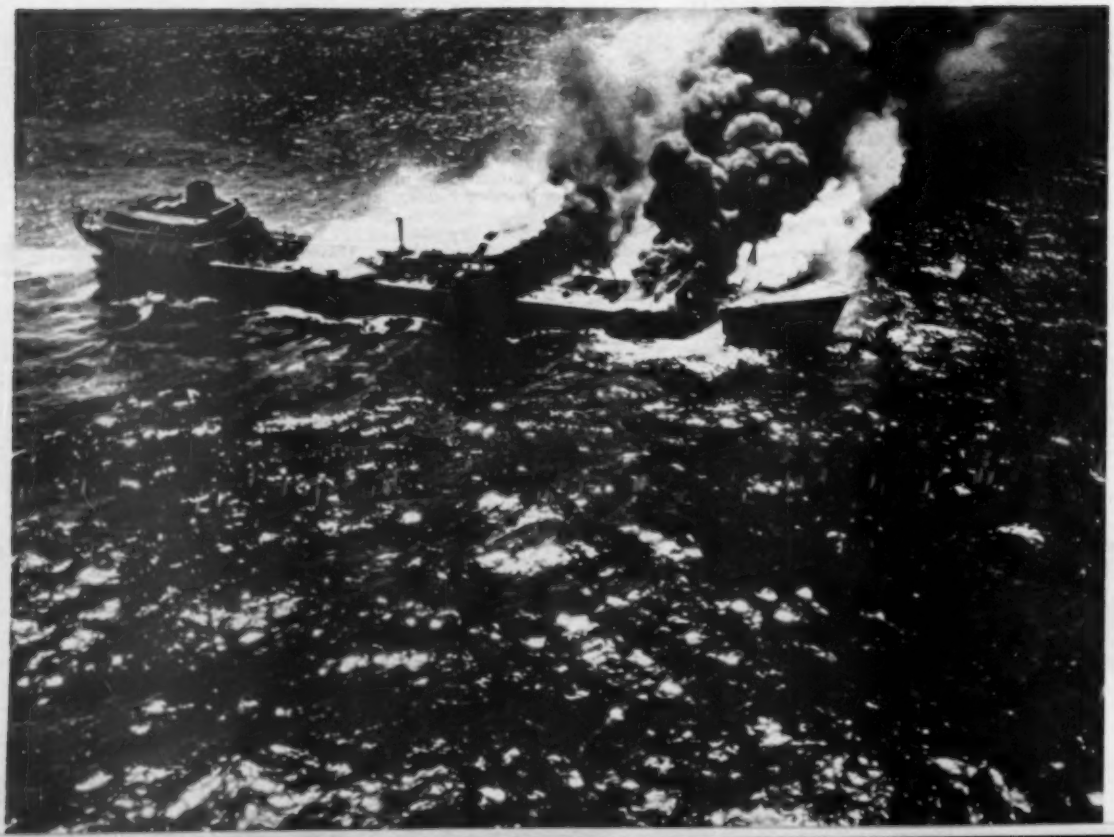
Fig. 8. Aerodynamic cause of unstable pitch-up.

to give the same standard of reliability as a properly designed duplicated hydraulic system or as an unduplicated mechanical system. This in turn leads to problems in the maintenance and inspection of practical Service aircraft. Although such complications have to be accepted in guided weapons, these always have a degree of unreliability which cannot be accepted in the stability and control of a manned aircraft. This emphasis on safety makes the aircraft more reliable and therefore more economical as a means of guaranteeing destruction of a given target.

These considerations do not, of course, prohibit the use of an autopilot to help the pilot whilst he is concentrating on his radar or other instruments, but this should be designed so that the "running away" of any servo cannot put the aircraft into a dangerous condition before the pilot has time to switch out the autopilot. The basic gyro and computer elements are then available for improving the weapon-aiming characteristics, but any failure of electronics should not be allowed to prevent the pilot from completing his task. This means that the aircraft must have good inherent stability and control and a simple instrument system.

Future developments in manned military aircraft therefore depend on the way in which these automatics are used to allow man time to play the parts which electronics can never replace. His most important attribute is his relentless determination to press home his attack, adapting his tactics to any changes in the situation caused by enemy action or any shortcomings of his own systems. This proper combination of man with automatics becomes irreplaceable in any future Korea, Suez or Oman, or as an additional deterrent to the world war that we hope will never start.

FROM THE CAMERAS OF COASTAL COMMAND



Left, "World Splendour on Fire."
F/L. G. C. Cowling and F/Sgt. A. Murphy, No. 224 Sqn., third in air-to-sea, merchant vessel, class.

Centre, "Up for Air."
F/L. B. Gait and Sgt. E. A. Howells, No. 120 Sqn., third in air-to-sea, Service vessel, class.

Right, "H.M.S. Barfleur."
S/L. P. Holland and Sgt. T. Castley, No. 224 Sqn., winners air-to-sea, Service vessel, class.

Left, "Shackleton Mk 2 over Cornwall."
F/L. G. L. Huntley and Sgt. E. J. N. Gregory, No. 228 Sqn., first in air-to-air class of competition.

Right, "Volcano in the Azores."
S/L. J. Nowakowski and F/L. P. J. King, No. 224 Sqn., 3rd, air-to-ground class.

FOR the second year in succession, R.A.F. Coastal Command has held photographic competitions devised by the command photographic officer, S/L. S. Hoskin. The squadron competition, in which entry by all squadrons was compulsory, consisted of four classes: (1) air-to-air, (2) air-to-ground, (3) air-to-sea, merchant vessel, and (4) air-to-sea, Service vessel. First was No. 228 Sqn., stationed at St. Eval in Cornwall; last year's winners, No. 224 Sqn., at North Front, Gibraltar, took second place. Third was No. 269 Sqn., based at Ballykelly, Northern Ireland. The Inter-Station Competition comprised eight classes of ground photography, covering a wide range of subjects. An easy winner, with four first awards, one second and one third, was H.Q. Unit C. C., at Northwood, Middlesex. Aldergrove took second place and St. Mawgan third. In comparison with last year's entry the standard of photography was much improved, but in the squadron competition there still appeared to be some lack of co-operation between the aircrews who made the exposures and the ground staff who did the processing and printing. It is good, however, to see the enthusiasm with which the Command photographic units have accepted the challenge to turn out original work of high quality. The selection of prints displayed on these two pages has been made on the score of suitability for reproduction rather than on high placing in the competition results.

J. Y.

PAKISTAN AIR FORCE

Structure and Growth of the Commonwealth's Youngest Air Arm

By HUMPHREY WYNN

Part I

AN invitation was extended last month by the Pakistan Air Force to "Flight" to see its facilities and form an impression of its operations during a ten-day visit to West Pakistan. The staff member to whom the assignment was given records his impressions in these pages.

MAURIPUR is a name which rings with aerial significance. Gateway to the Indian sub-continent and the Far East for many thousands of R.A.F. and Army personnel flown out from the U.K. during the Second World War, it is now the headquarters of the Pakistan Air Force; and on its runways and in its buildings memories of a busy past are quickly being swallowed up in the energetic establishment of new traditions. For though the P.A.F. has strong associations with the R.A.F., it possesses a keenly independent spirit imbued with all the enthusiasm of young men united in a youthful enterprise.

This spirit is thoroughly exemplified by the C-in-C., A. V-M. Asghar Khan, who at 37 is the youngest chief of a Commonwealth air force and probably the youngest such commander in the world. Quietly spoken, with a strong sense of humour and great charm of manner, he typifies the ten-year-old P.A.F., through a telling combination of modesty with obvious pride in its operational efficiency.

A.V-M. Khan's office at Air Headquarters is a large and cool room, its walls lined with maps and charts, overlooking Mauripur airfield. The story he had to tell of the P.A.F.'s history described how since 1947 it had been built up from almost nothing (a matter of three squadrons —two fighter and one transport, an A.O.P. unit and a communications flight) into a well-drilled force of fighter squadrons equipped with Sabres and Furies, supported by a Bristol Freighter transport and supply-dropping unit and backed by training squadrons, maintenance units and technical schools.

The P.A.F. had its genesis in the Indian Air Force, which was formed in 1933 with a single squadron, growing by the end of the war to ten squadrons which operated chiefly in Burma. When India and Pakistan became separate countries in 1947, the I.A.F. was divided between them, Pakistan getting the units already mentioned and such personnel as opted to serve with the new country's air force. In point of fact, there were only 44 pilots in a total of about 200 officers and 2,000 other ranks. This meant that the P.A.F. (like Pakistan itself) had virtually to start from scratch; and, again like its country, it has grown up rapidly in the last ten and a half years.

A. V-M. Asghar Khan, Commander-in-Chief of the Pakistan Air Force.

The brief outline of P.A.F. progress given by the C-in-C. was as follows. First-line equipment originally consisted of Hawker Tempests (there are no bomber squadrons), which were succeeded by Furies and later by Supermarine Attackers. Then, under an aid agreement signed between Pakistan and the U.S.A. in 1954, the P.A.F. began to receive North American F-84F Sabres in 1956. Most of its squadrons of these aircraft are at present based at Mauripur, where (as described in *Flight* last week), they gave the P.A.F.'s first public all-jet display on February 2.

Seconding Mauripur as a base in the Karachi area is P.A.F. Drigh Road, where are the H.Q. of No. 2 Group (whose A.O.C. is A. Cdre. M. Akhtar); Nos. 101 and 102 M.U.s; No. 1 Base Signals Depot; an Administrative Wing; and various other units, including the master provision office. Also near the Pakistan capital is Korangi Creek P.A.F. station. Here, where was formerly an Imperial Airways flying-boat base, has been established the P.A.F. School of Aeronautics. This was established in 1949 by Air Service Training, Ltd.; but it has now became an integral part of the P.A.F. and forms not only its equivalent of the R.A.F. Apprentices' School at Halton but also a technical training centre for P.A.F. pilots and engineering officers.

Continuing the broad outline of P.A.F. organization given by the C-in-C., other bases are at Quetta, Lahore, Sargodha, Peshawar, Chaklala, Risalpur and Kohat. These are all in West Pakistan. At present there are no P.A.F. squadrons in the east wing of the country, though a large number of airfields exist there which were built during the war and are now being made serviceable. There are also P.A.F. recruiting centres in East Pakistan, a glider unit and some communication aircraft and altogether about 400 personnel.

Conversion of P.A.F. pilots on to jet aircraft started originally in the U.S.A., but is now done entirely in Pakistan by No. 2 Fighter Conversion Squadron at Mauripur. One aspect of training (P.A.F. pilots at present begin their flying on Harvards) to which particular attention is given is instrument flying. The C-in-C. remarked proudly that his Air Force is "very keen" on I.F. and that its standards were "as high as in the R.A.F.," with the tests given being "sometimes more difficult." (In the Karachi area, of course, there is much less opportunity of experiencing actual I.F. conditions than in the U.K.; though dust-storms can often present serious difficulties.)

Flying training started in the P.A.F. eight years ago, with pilots going straight from Harvards (on which they now have to do about

Below, the scene at Mauripur on July 23 last year, when A. V-M. Asghar Khan, as the first Pakistan C-in-C. of the P.A.F., took over command from A. V-M. A. W. B. McDonald. The impressive line-up of aircraft gives a good picture of the P.A.F.'s chief equipment—its Sabres and Bristol Freighters. The motto under the P.A.F. crest (reproduced in the heading) is in Persian and means "Whether desert or sea, it is under my wings."

Whirlwind Helicopters on H.M.S. Bulwark

The Alvis Leonides Major engine powers the new Westland Whirlwind Helicopters now in service with the Royal Navy. The Leonides Major gives the Whirlwind a 30% increase in rate of climb and 100% greater ceiling.

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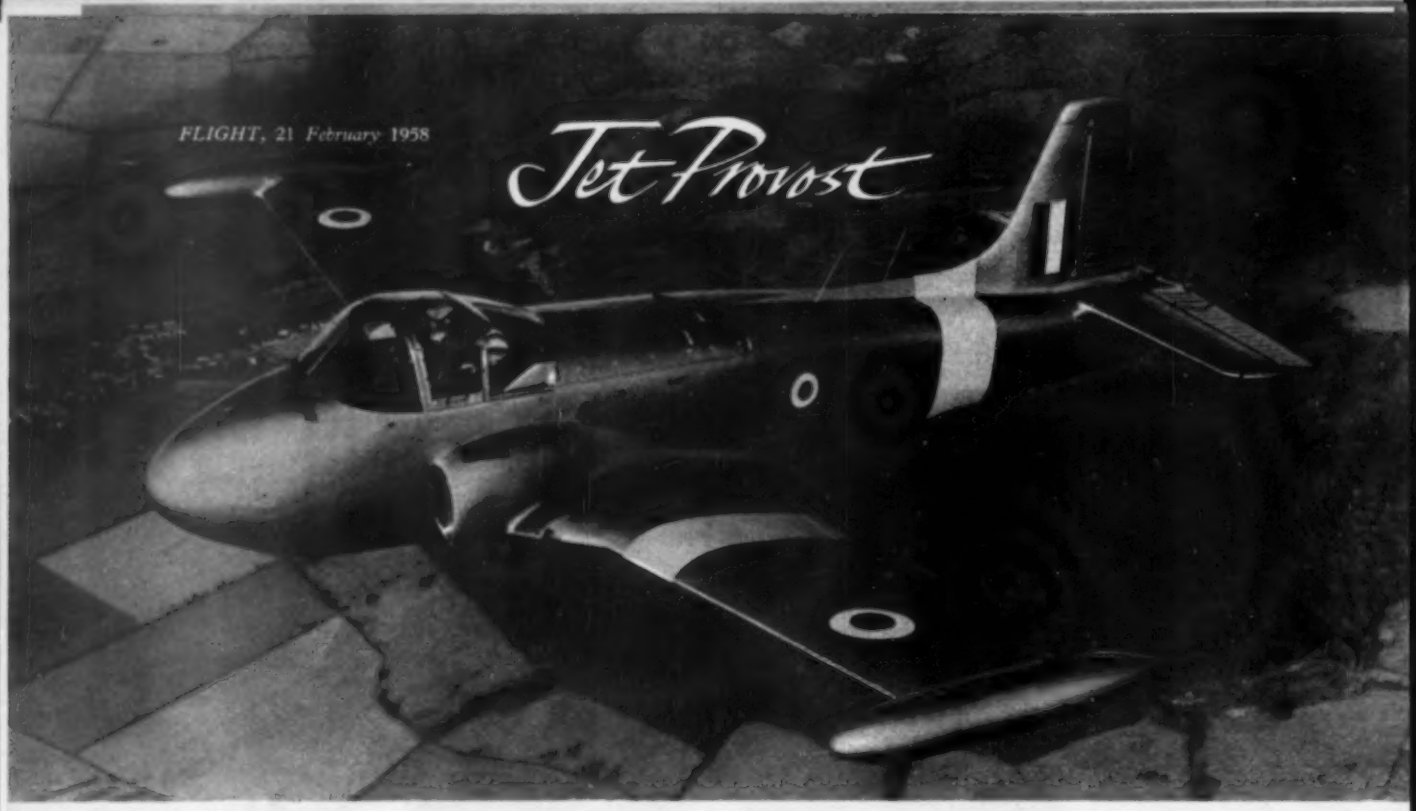

Two years' service with the Royal Air Force has established the Jet Provost ab initio/basic trainer as the best aircraft for its purpose, and the Mk 3 powered by one Armstrong Siddeley Viper Turbo Jet is now in production for the re-equipment of Flying Training Command.

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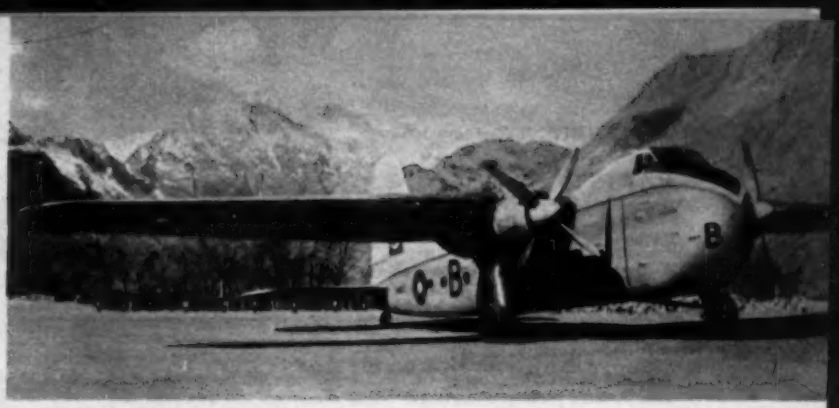
PAKISTAN AIR FORCE . . .



A Bristol Wayfarer of No. 6 Squadron, with whom the author flew on his visit to P.A.F. stations, seen at the Gilgit landing strip in Kashmir. The rugged nature of the countryside over which the squadron's supply-dropping operations are carried out can be appreciated from the impressive background of snow-covered mountains.

"Flight" photograph

200 hr) on to Tempests—a difficult transition. Nowadays pilots pass from Harvards to T-33s before converting to Sabres. The C.F.S. Examining Wing has been out to the P.A.F., and so has a Transport Command categorizing unit; in addition a team from the C.F.E. has visited Pakistan. Nowadays the P.A.F. awards its own flying instructors' and transport ratings. Referring to its close links with the R.A.F., A.V-M. Asghar Khan said: "We are very anxious to remain in close touch." One way in which he hopes this contact will be physically nourished is by having P.A.F. pilots temporarily attached to R.A.F. squadrons. (There are at present three members of the R.A.F. serving in the P.A.F. on a contract basis, the most senior—A. Cdre J. K. Rotherham—being Assistant C.A.S. (Maintenance). The present C-in-C. is the first Pakistani to command the P.A.F.: his R.A.F. predecessors were A.V-M. L. W. Cannon; A.V-M. (now Air Marshal Sir Richard) R. L. R. Atcherley; and A.V-M. A. W. B. McDonald, who relinquished command only last autumn).

Referring to the training aircraft used by the P.A.F., the C-in-C. said that "one day" the Harvard would have to be replaced and the Air Force had considered both the Jet Provost and the Fouga Magister; but the P.A.F. would like to get new trainers under the U.S. aid programme when the time came for it to get rid of its Harvards.

As to operational types, the C-in-C. was non-committal about future equipment, pointing out that the P.A.F. had not long had its Sabres. Though it has as yet no bomber aircraft, the increasing strength of the Indian Air Force—three times the size of the P.A.F. and being built up to four times—may force the P.A.F. to acquire some. As the C-in-C. put it: "We hadn't thought about bombers until India made us do so" (making reference to the Canberras bought by the I.A.F.). The few Halifaxes the P.A.F. possesses are "not being used"; its Attackers are kept serviceable but not employed. The C-in-C. summed up the P.A.F. choice of aircraft by saying "We like to keep to a simple number of types."

Transport operations in the P.A.F. are carried out by Bristol Freighters, with some Wayfarers for special duties. The Freighters are well liked (despite their modest speed) and being easy to load and with a good short-field performance suit the purposes for which they are employed. Among their tasks are the transport of engines and other aircraft spares, and supply-dropping in highly mountainous Pakistan areas of Kashmir.

The P.A.F. also has one Viking and a V.I.P. Viscount, the latter being used as a Presidential aircraft; it was employed on February 2 to fly the King of Afghanistan from Karachi Civil Airport to Mauripur when he came with the President to review the P.A.F. and watch its air display.

Two other matters of special interest which the C-in-C. mentioned were that the P.A.F. is considering a new trade structure (its present one follows R.A.F. lines); and the existence of two English-style public schools which it runs at Sargodha in the Punjab and at Lower Topa in the Murree Hills. (These schools, like the Shahin Air Training Corps, owe their origin largely to the imaginative genius of Air Marshal Atcherley, whose term as C-in-C. is widely remembered with respect and admiration in the P.A.F.). Although they are sponsored by the Pakistan Air Force, there is no absolute obligation placed on the boys to join it after they have finished their education.

To visit the most important P.A.F. stations after being "briefed" by the C-in-C., and to see it in action at the February 2 display, was to build up a vivid picture of its enthusiasm and organization—and to receive most pleasant impressions of its generous and thoughtful hospitality.

Mauripur, in addition to being a base for Sabre squadrons and the conversion squadron equipped with T-33s, houses the Air H.Q. staff—A.H.Q. being broadly the P.A.F. equivalent of the Air Ministry, with A. Cdre. M. Rabb as its remarkably genial and friendly Chief of Staff.

The C-in-C.'s youthful age for his high position has already been mentioned, and similar youthfulness characterizes the other holders of senior posts in the P.A.F. One reason given for this is that senior posts in the pre-partition Indian Air Force were chiefly held by Hindus and Sikhs who after 1947 stayed with the I.A.F., so that the newly formed Pakistan Air Force has had to find senior officers from its predominantly youthful ranks. This seems to have had quite an exuberant effect upon the Service as a whole. In fact, anyone familiar with the R.A.F. in its formative days during the 1920s and early 1930s would probably find much in common with the present P.A.F.; for like the early R.A.F. it is small in numbers, most of its members (at any rate among senior officers and aircrew) knowing each other personally, and its dominating characteristic is thus young enthusiasm in a pioneering atmosphere.

All the pilots are on the average aged only 24-25, and meeting over lunch those who were to fly Sabres in February 2 display was to find in them very much of an R.A.F. spirit—particularly that of Fighter Command, with the same kind of jokes and leg-pulling, an outward nonchalance concealing a solid determination to achieve the highest possible operational standards.

Korangi Creek P.A.F. station, some six miles out from Karachi, houses the School of Aeronautics. Here again an R.A.F.-like spirit is very prevalent, the school being organized on the lines of Henlow and Halton, for its scope is a wide one. Originally run by A.S.T. but now completely administered by the P.A.F., the school not only gives P.A.F. apprentices a three-year course (as at Halton); it also trains maintenance officers in basic engineering on a one-month course; gives pilots a two-week course on the engine and airframe and ancillary equipment of F-86s; and provides airmen who are entering Group II trades with a year's course after they have done twelve months' basic training at the Recruit School at Kohat. The airmen then go to various units for three or four years and come back to Korangi Creek for a conversion course to become mechanics and fitters. In addition some apprentices and technicians of Pakistan International Airlines receive training, altogether over 600 personnel being under instruction on the station.

The Apprentices' School started under P.A.F. aegis in 1949 and its present C.O. is W/C. A. M. Khan. Training is divided into two main sections, academic and practical, the latter instruction being given in hangars and workshops. Educational qualifications for entering the P.A.F. are high, entrants having had to reach matriculation standard at school; all instruction is given in English.

Training facilities at Korangi Creek are impressive. Most of the apprentices at the outset may have scarcely any, or at best a limited, knowledge of chemistry and mechanics. At the station there are laboratories where they are taught these subjects and the basic principles of electricity, physics and aerodynamics. They also have the use of the station library of 10,000 books, and are instructed in subjects like engineering drawing and the fundamentals of radio and electronics. (Not all the students at the school are Pakistani; six Jordanians are at present under instruction there.)

Thus Korangi Creek provides a thorough basic engineering training, and there is a similar comprehensiveness about its aero-

Hawker Furies of No. 9 Squadron, which is the last squadron in the P.A.F. to be equipped with piston-engined fighters and is based at Kohat. R.P.s as used on the aircraft can be seen in the foreground.

PAKISTAN AIR FORCE . . .

T-33s of No. 2 Fighter Conversion Squadron of the P.A.F. at Mauripur. The tip tanks and fins are painted a distinctive red.

nautical instruction, types of aircraft at present in use by the P.A.F. (and their predecessors) being dissected and analysed for and by the students.

In the engine laboratory, b.h.p. calculations are carried out on test-beds; familiarization with Gipsy Major and Hercules is provided as a basis for working up to the more complicated turbojets (instruction is being given on the Rolls-Royce Nene, but this will eventually be replaced by the J47 as used in the Sabre, a sectioned J47 having been installed about a month ago); and every part of the Sabre is illustrated and explained for the benefit of apprentices, engineering officers and pilots.

Through working sectioned models the ejection seat and canopy operation, cockpit air-conditioning and pressurization, instrument and electrical and fuel and hydraulic systems, armament, and camera and gun-sight operation, are explained in detail.

In the airframe section at Korangi Creek are complete aircraft, including Tiger Moths and Furies, on which practical work can be carried out; in the Halton Block, which overlooks the creek where fishing boats ride picturesquely at anchor on the glassy sea, is the Technical Officers' Training School. [In a reading room there one was gratified to see copies of *Flight* with a typewritten notice stuck to their covers, marking certain articles for especial perusal.]

Each section at Korangi Creek holds end-of-term examinations; vigorous checks are made by the school authorities to ensure the maintenance of standards; and final examinations are conducted by the Central Trade Test Board.

One's impression of the station, as of the P.A.F. generally, was that it is doing a most efficient job. Everything is organized on strict disciplinary lines and there is an air of single-minded keenness. The neat appearance of the station typifies the thoroughness of its work and neither A.S.T. nor the R.A.F. need feel any doubt that the original pattern has been in any way diminished.

At Drigh Road all fourth-line servicing is done for the whole of the P.A.F.: the most important of its units, therefore, is No. 102 M.U., which carries out this work; but scarcely less important is No. 101 M.U., which is the force's biggest supply depot. Also at Drigh Road is No. 1 Base Signals Depot, which was started in 1947 and has a radar flight, drawing its personnel from the Technical Training School. Another important unit on the station is the master provision office. On the flying side, there used to be a target-towing flight, equipped with Furies, which moved to Mauripur when reconstruction work began on the Drigh Road runway and is to remain there. There is also a test flight allied to No. 102 M.U. The station is commanded by G/C. A. M. Allahdad, and one of the most pleasant of many pleasant social functions in Pakistan was a ceremonial luncheon in the officers' mess under his presidency.

No. 102 M.U., under the command of W/C. K. M. Ahmad, does 3rd line servicing for P.A.F. stations in the South (in addition to 4th line servicing for the Service as a whole). Unlike R.A.F. maintenance units, this one has no industrial backing; and much of its equipment—for example that for filling instruments with helium—has had to be made by the P.A.F. itself. As in many other aspects of P.A.F. organization, there has had to be a good deal of "improvisation." Similarly, when once salvage work used to be sent to the U.K., reclamation and salvage is now done at Drigh Road and modifications are also carried out there.

A great new project is afoot at the station, the building of an air-conditioned overhauling plant for the J47 engines of Sabres, where these powerplants will be stripped, cleaned, re-worked as necessary and re-assembled. Test-bed facilities are also to be provided on the station for all types of engine used by the P.A.F., one which already exists for gas-turbine units having been constructed under the personal supervision of No. 102 M.U.'s enthusiastic commander. Altogether the station typifies the keen pioneering spirit evident in all aspects of P.A.F. work.

In pens around the airfield at Drigh Road are stored some of the Tempests which the P.A.F. formerly operated. These are not flown nowadays but are kept in a serviceable condition.

At the station are the headquarters of No. 2 Group, under A. Cdre M. Akhtar, which is responsible for maintenance and supply.

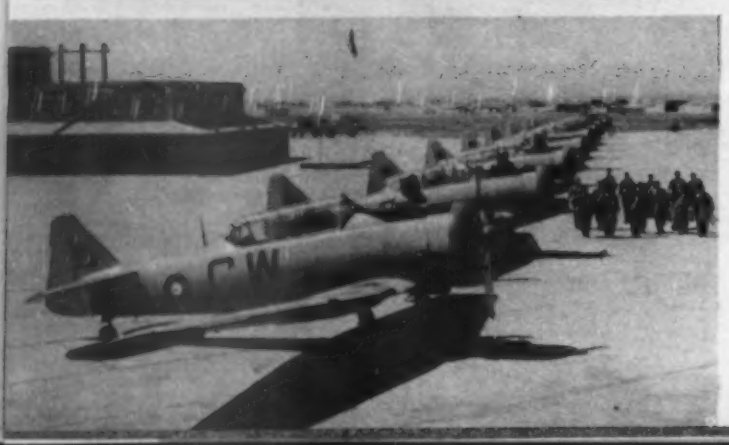
It is important that the functions of the two Groups into which the P.A.F. is divided should be made clear, for they are not —as in the R.A.F.—sub-divisions of Commands, which do not exist in the P.A.F. No. 1 Group, which has its headquarters at Peshawar and is commanded by A. Cdre. M. Nur Khan (who at 35 is probably the youngest air officer anywhere in the world), controls the P.A.F.'s operational aircraft—its fighter and transport squadrons—and its flying training. Both it and No. 2 Group at Drigh Road come under Air Headquarters which is in turn subject to the Pakistan Defence Ministry.

This division of functions between the two Groups can be seen in practical operation on a single station like Kohat in the North-West Frontier Province, where No. 9 Squadron (equipped with Furies) is under the control of No. 1 Group but the Bristol Freighters stored on the station are the responsibility of No. 2 Group. Until recently, the division was on a geographical basis, No. 1 controlling the Northern area of the country and No. 2 the South. The new "vertical" arrangement is still in its trial stages.

In the Officers' Mess at Drigh Road (where that delightful English tavern known as *The Rose Refresht* is still maintained) there is on the wall a plaque commemorating the handing-over of the station by the R.A.F. in 1947 to what was then the R.P.A.F. (The "Royal" prefix was dropped in March 1956 when Pakistan became a Republic.) There are also, carved into the heavy wooden doors of the dining-room, the badges of several R.A.F. squadrons —including Nos. 5, 11 and 30—which in former days were based at Drigh Road. The same squadron badges are in evidence at P.A.F. stations in the north of Pakistan, and particularly on the north-west frontier one is conscious of a strong historic link between the two Services. Many R.A.F. personnel who served in that area in pre-war days will have vivid memories of it, and perhaps would find that the stations they once knew are outwardly much the same, though new buildings have, of course, been added. Miram Shah, however, because it is an enclosed fort, is very much the same and provides a dramatic introduction to the rugged frontier countryside over which the P.A.F. now operates.

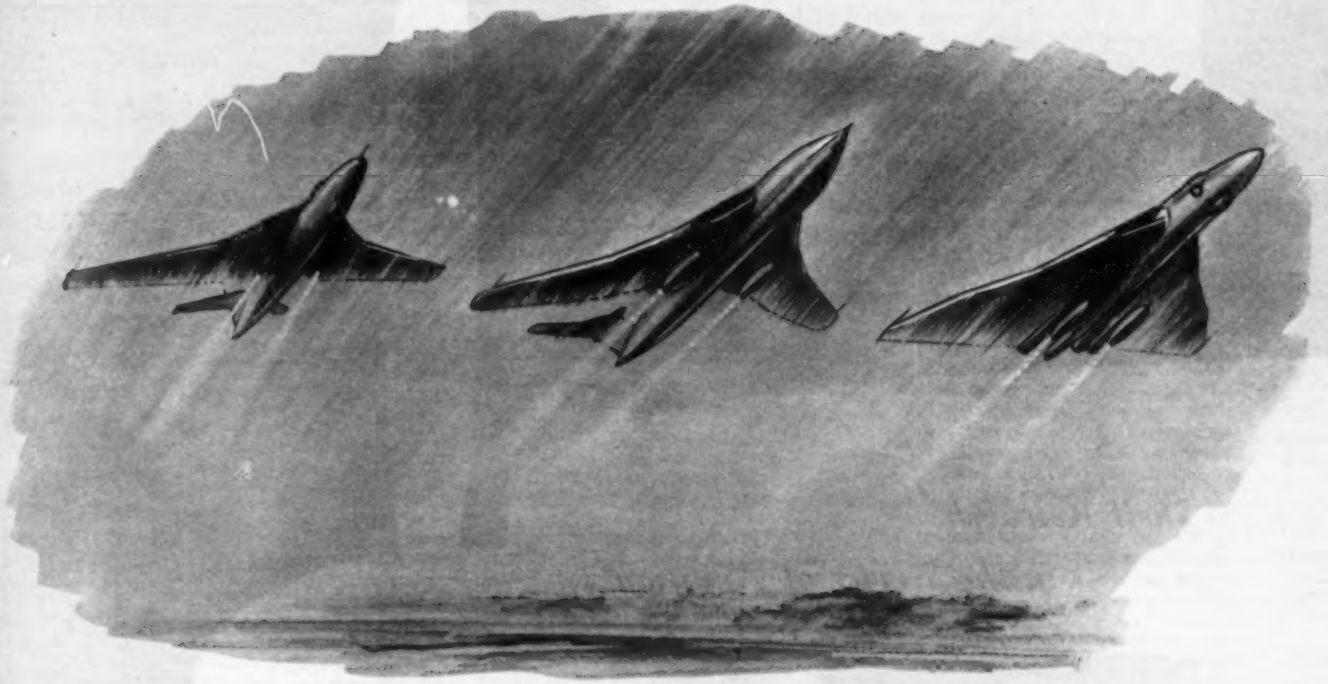
I travelled up there by Bristol Wayfarer of No. 6 Squadron, which is based at Lahore and has on its badge a camel with a Persian motto which in free translation means "No journey is too long." Certainly this proved the case in their kindness and efficiency on flights during the subsequent five days to P.A.F. stations across the length and breadth of West Pakistan.

(To be continued)



Left, students at the Risalpur College—P.A.F. equivalent of Cranwell—going out to their Harvards for flying training. From Risalpur they proceed either to T-33s at Mauripur or to the Bristol Freighter conversion squadron at Lahore. Above, apprentices drilling at the P.A.F. School of Aeronautics at Korangi Creek near Karachi.

SPECTRES AND SUPER SPRITES
are behind the V-Force



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SHELL

Straight and Level

I DID not envy Mr. R. E. Hardingham, chief executive of the Air Registration Board, during his interview on the B.B.C. Television programme *Panorama* last week. He was asked by Richard Dimbleby why the airlines do not fit rearward-facing seats. There seemed to be no doubt in Mr. Hardingham's mind about the safety advantages of such seating; he had recommended its adoption to the M.T.C.A., who had twice recommended it to I.C.A.O. But there it had stuck.

I wonder how many more lives are going to be lost, and how many more terrible injuries sustained, because airlines and governments continue to shirk this issue? One cannot blame I.C.A.O., because an institution is only as effective as its members; so I submit that the British Government should keep on pressing in I.C.A.O. for rearward-facing seats, enlisting American aid if it can. And, *pour encourager les autres*, rearward-facing seats should be made a mandatory future requirement for British Certificates of Airworthiness.

There need be no fuss: nor need the airlines fear the loss of a single passenger. They can still have their lounges, sleeperettes and berths, so long as a rearward-facing seat is available for everyone in the event of a crash-landing. Passengers are not going to be squeamish about such "obvious" provision for emergencies, any more than they are squeamish about safety belts, emergency lifebelt drill, or prominently labelled emergency exits.

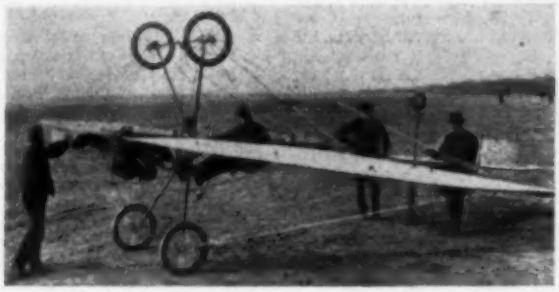
The case for rearward-facing seats is incontrovertible. I am sure we shall, in years to come, look back with curiosity on the primitive age when people sat facing forwards in airliners.

● Scrap. What a familiar word! One character who should know recently estimated that nine per cent of the work going through the shops in his factory ended up as scrap, through drawing errors, operator faults, and so forth.

But some people are going to have to change their ideas, and pretty quickly too. Modern aircraft are made from such expensive bits and pieces that scrap is almost taboo. Take a DC-8 wing-skin, for example: a single piece of roll-tapered, machined high-strength alloy with an area of almost a thousand square feet. Imagine what would happen if somebody made a mistake, or found a flaw, just as the skin was about to be shipped to Douglas. Any titanium, even in small bits, has to be treated like solid gold. "What Are *You* Doing About Materiel Conservation?" ask the placards prominently displayed all over Lockheed's Burbank plant.

● The Homburg-hatted gentlemen in my picture do not appear to be crumpled up with mirth; indeed they seem to be very serious, and so does the helmeted aeronaut in the cockpit. So I can only assume that the landing-gear configuration is not as crackpot as it seems.

I found the picture while flipping through *Flight's* archival copy of *Jane's All the World's Aircraft* for 1914. The accompanying description leaves my curiosity unsated: from it I gather that the machine was a Grade single-seater



monoplane, constructed in 1913 by the Hans Grade Fliegerwerke of Bork, Germany. About "50 various" were built.

Can anyone enlighten me? Was it a new way of landing on ceilings? Or was it for the Antipodean market?

● My recent remarks about aeroplanes "looking right" has prompted a comment from an Old Boy of the D.H. Technical School. "I was taught the following ploy," he writes. "When invited to comment on a new aeroplane, observe the following rules: Frown with concentration and walk round the aircraft three times. Then suggest that the structure looks a bit on the heavy side, that the c.g. is too far aft, and that the vertical tail area is too small."

● Some "highly supersonic" aircraft have wings with leading edges as sharp as those of a missile (e.g., the F-104, which has to be padded to prevent injury to ground crews). It seems to me that erosion may be quite a problem, even with a knife-edge of steel; who knows, we may yet see the stencil "re-grind every 10 hr (in rain, 2 hr)." The trouble doesn't arise with missiles; they don't fly long enough.

● An odd thing about American Airlines: while attracting more people in a year than any other operator they have steadfastly refused to paint their aircraft, apart from adding their own restrained lettering and cheat-line. On a Boeing Intercontinental this may actually give them several hundred pounds' weight advantage over T.W.A., and there is no reason to believe that the surface finish will be in any way inferior. Paint can have quite an effect on performance, even at low speeds. I remember the 1939 Belgian-built Fairey Battles, whose glossy camouflage gave them a distinct edge over our matt-finished machines. Of course there isn't much matt paint on R.A.F. aircraft today, but has anyone worked out what we would save by not using any at all? The U.S.A.F. seems to get along well enough.

● A *Flight* colleague lives about a mile from, and on the approach to, a V-bomber runway. He is used to sudden aircraft noise, and is not the sort who writes fusspotty letters to his M.P. and to the local paper about the way he and his wife rush outside to hold the baby down in its pram each time "one of them jets" flies past.

But he defies anyone—including cauliflower-eared jet test-engineers—not to flinch when one of these big aircraft climbs away over his house after take-off. He challenges anyone to begin to describe the mind-splitting blast and the disruption of quiet family life which this kind of aeroplane—and many, many others from airfields all over the land—inflicts upon those below them at every take-off.

We must not under-estimate the reaction of the public to the growing social evil of jet noise. The reaction will, as the airlines move into the jet age, be violent; and I think the Government knows this. The Minister of Transport recently ruled that the new jet airliners, British and foreign, will have to have their noise measured and accepted.

But would it be too cynical to ask his acoustics engineers not only to measure the noise, but also to *listen* to it? "Decibel levels" are not even of academic interest to a hostile public—a public which, after all, pays for our airports, and which, in the final analysis, is the customer of our airlines and of our aircraft industry.

● Comment from expatriate British engine-installation draughtsman in America (one of those who is doing nicely, thank you): "These people don't *solve* their problems, they trample them to death."

● Supersonic fighters and bombers, intercontinental missiles and what-have-you are now a sort of Big League business; the entrance fee is a billion pounds and the subscription a hundred million a year. We in Britain are holding on by the skin of our teeth, and things are going to become more and more difficult. When I think what we could do with all the money that we put into this Big League work my flesh tingles. Couldn't we just chuck the whole idea and live like lords? ROGER BACON

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Restrictions on the Private Pilot

I READ with interest Mr. V. H. Bellamy's letter ("Restrictions on the Private Pilot," *Flight*, February 7), and feel it is a pity that he should have spoilt his otherwise good arguments by an attack on control officers—one which should raise a protest from pilots, both commercial and private.

It is well known that the standard of training and knowledge required by control officers before they are licensed is very high. The pilots of my company, and many others I know, have no doubt about their efficiency as a body today, and feel it is quite wrong to "snipe at" them because of faults and inadequacies which may exist in the system they have to administer.

I will go so far as to say that if all of us in civil aviation were as conscientious and tolerant as the average control officer, there would be far less bickering generally, and I look forward to reading the reply which surely must come from the Master of their Guild.

Croydon Airport, Surrey. T. W. MORTON,
Managing Director, Morton Air Services, Ltd.

THE discussion of half-truths by your correspondent Mr. Bellamy deserves some respect. He is evidently an authority on them, judging by his letter. He accuses "Airline Pilot" and myself of representing "big commercial interests." I am, in fact, an ordinary flying instructor who has spent the last twenty years attempting to attain some degree of proficiency in my profession. It is surprising that I am disgusted at the low status to which the professional flying instructor has sunk?

Mr. Bellamy is hardly likely to fool anyone with his red herrings, least of all myself, who has spent some part of my career as C.F.I. of a flying club. My criticism is not of the clubs' P.P.L. training. The organization would appear to be adequate to achieve this. What I am concerned about is the growing attempt by clubs, which are not qualified, to sell commercial-pilot training at cut rates.

The Home Command visits are to check the instructors *up to P.P.L. standard*, which is as far as the cadets go. This standard is as low as can be allowed with safety. The fact that the visits have to be made at all indicates a doubt at the Air Ministry as to the validity of all club P.P.L. training.

The M.T.C.A.-approved thirty-hour course is, again, only for P.P.L. candidates.

Is Mr. Bellamy really *sure* that *all* club C.F.I.s have C.P.L.s? Surely it should not be necessary for British boys to "fight their way through" to a Commercial Licence (presumably through a sea of aircraft wreckage)? Is this the way our Merchant Navy captains are trained (through yachting clubs and a few quick crammers to the *Queen Mary*)? Perhaps Mr. Bellamy can explain how it is that so many club instructors are achieving sufficient experience to obtain a Commercial Licence *by instructing Commercial Licence candidates*? And why, when they have the licence, they leave instructing to obtain a more lucrative post? Perhaps he can also explain why so many of these so-called instructors fail their C.P.L. tests at Stansted.

Last of all should the training of future airline pilots be in the hands of people who appear to resent airline procedure, air traffic control, the M.T.C.A. and anyone else who wants to put the profession on a sound footing?

Warsash, Hants. PERTURBED.

Turboprop v. Turbojet

RECENT pleas from airlines for higher fares, coupled with doubts about the ability to pay for new equipment, go hand in hand with complaints about the low earning-power (less than 2 per cent) of capital invested in the air transport industry.

Much depends, of course, on the earning capacity of the aircraft employed and although the work-capacity of the large American jets is not in question it remains to be seen if it can be fully utilized in practice and whether or not it is matched by effective earning power under normal competitive operating conditions.

The only intelligible remark one hears, in this context, is that passengers will *always* go for the fastest aircraft available. Is it too much to hope that someone will offer us some rational evidence in support of this view? For example, what load-factors can El Al and B.O.A.C. expect if they continue to operate Britannias in competition with jet aircraft? Are we to suppose that the Britannias will run empty and the 707s full?

On the other hand, if turboprop aircraft continue to attract a substantial share of the traffic, at what minimum load-factor will they continue to earn money, and will their competition result in the larger jet aircraft operating at a loss?

If B.O.A.C. cancelled their orders for 707s and Comet 4s (the latter aircraft could be transferred to Transport Command) and purchased 60 extra Britannias with the money saved, they would have ample work-capacity to last them till 1963, when the VC.10s become available.

Unless the industry pays greater attention to commercial considerations the expected growth in traffic may be brought to a sudden halt. In any event, as airlines grow, the burden of direct and indirect subsidies may very well reach a level that no government can support. The answer is, surely, aircraft that can earn a handsome return on capital invested, together with the minimum of expenditure on navigational aids and airport facilities consistent with safety and efficient traffic handling generally.

Twickenham, Middx. G. S. RICHARDSON.

B.E.A. and VTOL

I SHOULD like to offer a small observation on Dr. G. S. Hislop's very reasonable comments on a VTOL study printed in your issue of January 31; this is in respect of operating cost.

The extent of the use which operators will make of any form of airworthy aircraft (including the helicopter) will depend on its operating cost. A VTOL aircraft with the operating costs of the DC-3 and cruise speed of the present-day aeroplane would find a vast market. It would rapidly take over all air traffic on stages up to 300 or 400 miles and with the convenience of VTOL facility attract many more people to air travel.

Such a low level of operating costs is, of course, asking a lot and could take many years to get; present levels of helicopter reliability, developed over 20 years, would certainly not be achieved overnight.

However, the aeroplane sets the standard for cheapness and reliability to which air transport is geared, and no aircraft which does not approach these standards can hope for wide application as a passenger carrier. R. H. WHITBY.

London, N.W.3.

[Mr. Whitby, of B.E.A.'s project and development branch, was the author of the study referred to above. Dr. Hislop's comments were appended to our summary of the study—Ed.]

Rockets and Bases

WE have heard a great deal in recent months about the plan (originally contrived between Mr. Macmillan and President Eisenhower at the Bermuda Conference) for the establishment, on Britain's East Coast, of launching bases for American-built intermediate-range ballistic missiles. Such bases, it is said, "will cover the ground area of London Airport," require 500 men per site to keep 15 missiles in operational trim, and cost in the neighbourhood of £10,000,000 apiece.

The size and complexity of the bases in question are, of course, related to the type of weapon they will employ—in this case, the Thor SM-75. Thor, a liquid-propellant rocket using liquid oxygen and kerosine, requires large base-storage facilities for propellant which, for safety reasons, must be dispersed underground. Elaborate fuelling facilities, with adequate safety arrangements, account for further cost and complexity.

Liquid oxygen is, of course, a highly volatile substance which boils at a temperature of −183 deg C; and, once fuelled, any rocket using it must either be fired or have its tanks drained within a comparatively short period. Experience with rockets of this type, from the German V-2 right up to Vanguard, Thor and Jupiter, has shown that if for any reason such vehicles have to be kept standing for any length of time after they are fuelled, the chances of a "misfire" increase measurably, a common source of trouble being the freezing of oxygen valves.

The difficulty of keeping a base in an instant state of readiness is therefore apparent, One is left with the choice of (a) waiting for a formal declaration of war before beginning fuelling operation—a rather futile procedure when a surprise attack by a foreign missile on the base in question would probably be the starting signal; or (b) maintaining a complex (and very expensive) routine of fuelling and defuelling missiles to ensure that the base is kept in a perpetual state of readiness.

One cannot help feeling that while the liquid-propellant rocket may have some value to a nation with belligerent intent, it has decidedly smaller worth as a weapon (to coin a phrase) "of instant and massive retaliation."

As for the base itself, unless a large part of it is built underground, it will be vulnerable to H-bomb assault, for it will be pin-pointed by any potential enemy and would obviously become

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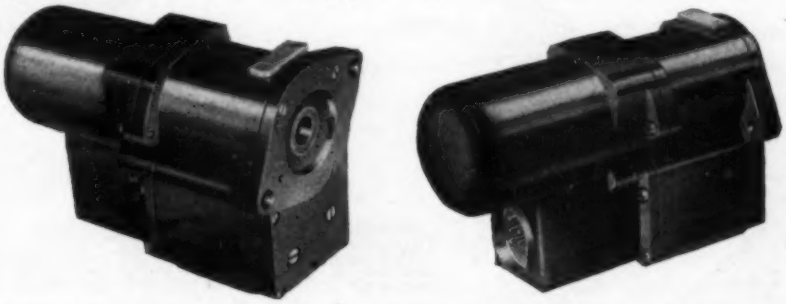

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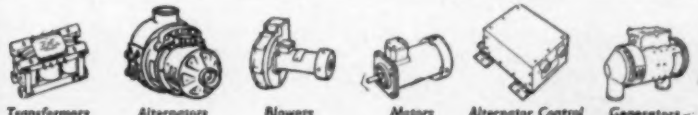

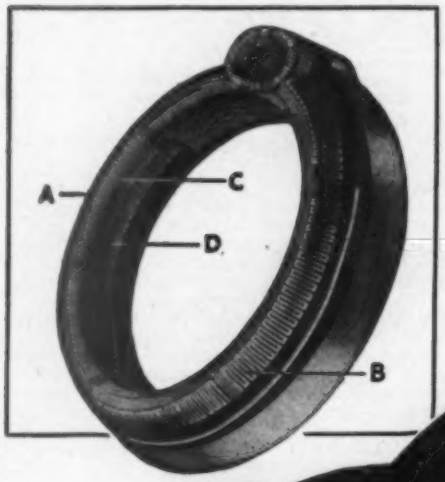

*A typical application: Dunlop thermal de-icing mat fitted to the intake of a Rolls-Royce 'Dart' engine. Circuit (A) applies continuous heat of highest intensity to the leading edge of intake. Circuits (B) and (C) are cyclic in operation and apply a lesser degree of heat to areas adjacent to the leading edge. Circuit (D), again cyclically operated, is situated further downstream of the intake and applies the lowest heat intensity.

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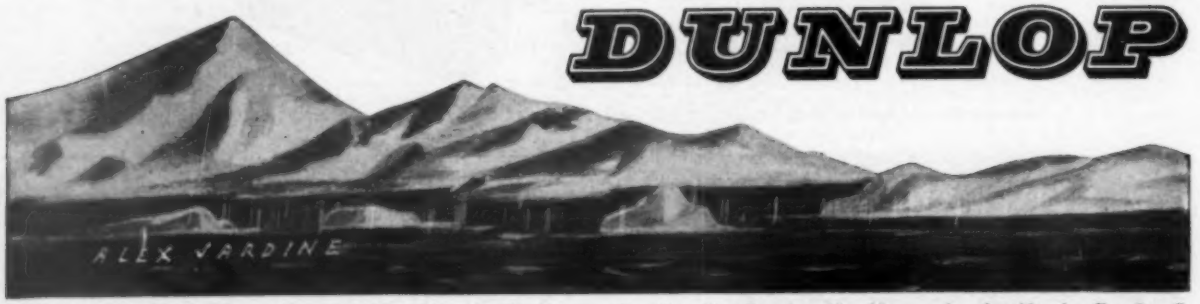

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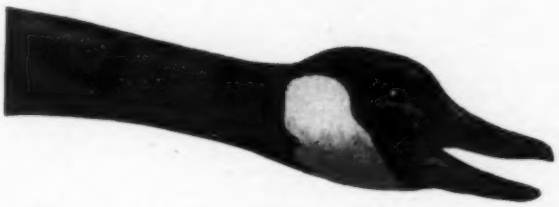
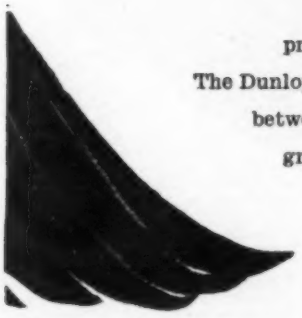
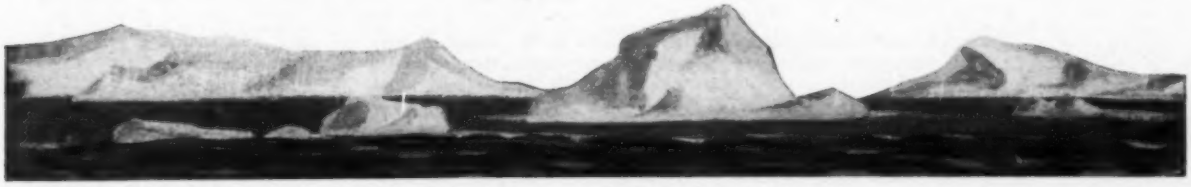


. . . north wind doth blow

LEAVING the warmer coasts of Florida the Canada goose flies high to its Arctic nesting grounds, impervious to changing temperatures. Fortunately, it is equipped not only with feathers, which provide admirable insulation, but a natural heating system. Aircraft are not so versatile in this respect. But those responsible for design and production can always call upon Dunlop for proven assistance with de-icing problems. The Dunlop electro-thermal method of de-icing, based on electrical heater circuits sandwiched between layers of rubber, allows effective surface heating which can be varied to give the greatest protection at vulnerable points. It has made a highly successful contribution to safety and operational efficiency in conditions which cause icing-up. For full details write to the address below.



DE-ICING SYSTEMS | **meet the needs of the aviation industry**



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This thermal blanket is in refractory fibre cased in .004 inch (.1016 mm) stainless steel. It was made-to-measure and is extremely light, the dimpled construction being responsible for its great strength. Specified for Rolls-Royce and Armstrong Siddeley jet and turbo-prop engines. Approved by the A.R.B.

High pressure fuel-cooled oil cooler for high performance gas turbine engines. This unit is used in the Armstrong Siddeley Sapphire S.A.7

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Success, to us, means the ability to solve problems; to produce something that will do a new job, or perhaps an old job in never-before-experienced circumstances. And then, of course, to make it a practical and economical proposition.

We have enormous experience and wide resources. If we can help you in any way with heat control equipment, please contact us. We are always at your service.

We are now introducing Sealed Blankets for Civil Aircraft

CORRESPONDENCE . . .

one of the first targets for enemy missiles. Indeed, had the Germans persisted in their original intention of building huge concrete launching bases for their V-2 rockets, those bases would have been blown to pieces by the R.A.F. long before they could have been put into operation. Instead, under General Dornberger's capable direction, a technique was devised whereby the rockets could be transported by rail and road and discreetly launched from almost any flat surface—even, on occasion, from a few planks concealed in a wood. Clearly, the launching of a missile four times the weight of the V-2 would require something a little more sophisticated than the old German rocket, but with fuelling problems eliminated it would obviously be a much simpler proposition than Thor.

In view of the inherent limitations of liquid propulsion-systems, one wonders if sufficient attention is being given in this country to the large high-performance solid-fuel rocket, which appears to offer a number of important advantages, including instant readiness, greater functional reliability, and ease of handling and storage.

The performance of "solid" rockets has been stepped-up considerably in recent years, and some of them (e.g., the ammonium perchlorate-polysulfide variety) are on a par with contemporary liquid combinations. In the United States, there is considerable enthusiasm for Polaris, a solid-propellant IRBM with a projected range of 1,500 miles, which has been specially tailored to the needs of the U.S. Navy for shipboard and submarine launching. This type of missile requires the minimum of support facilities and trained personnel, and if adapted for a ground-based rôle would eliminate a great deal of the complexity of our proposed bases.

Indeed, such is the promise of these energetic solids that the type of ballistic missile we are importing—and developing ourselves—may be rendered obsolete within a few years.

Is it wise to plunge ahead too far with big and possibly over-complicated bases before the alternatives have been thoroughly explored?

Whitton, Middx. KENNETH W. GATLAND

Monocular Vision

SOME seven or more years ago, Mr. E. S. Calvert, of the R.A.E., in collaboration with Capt. A. M. A. Majendie, put forward *The Parafoveal Streamer Theory of Visual Perception*, describing the manner in which visual clues were utilized during landings.

Your readers would be well served if you were to invite Mr. Calvert or Capt. Majendie to describe and illustrate their thesis, which is of considerable importance and interest.

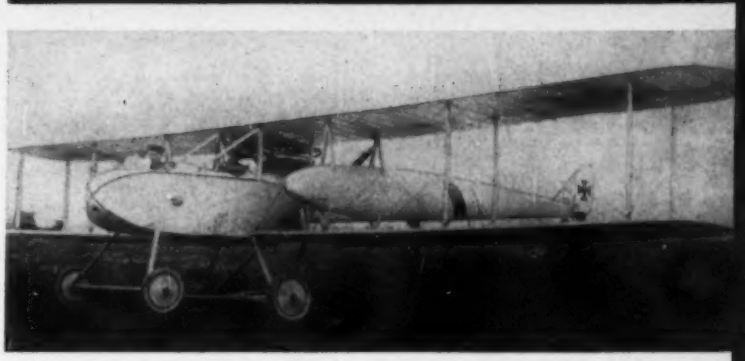
Stockport, Cheshire. O. W. NEUMARK.

[We extended the invitations suggested, and Mr. Calvert's reply is printed below—Ed.]

"In your issue of January 17 Mr. Tudor says that particular instances of one-eyed pilots who can fly well merely 'illustrate an admirable triumph over a disadvantage, and do not prove the disadvantage does not exist.' The word 'fly' might be taken to include tasks such as flying in formation and parking, and for these the loss of an eye would, of course, be a disadvantage—although, as 'Cyclops 2' points out, the disadvantage can be balanced by extra care and self-training. I think, however, that Mr. Tudor is maintaining that for the most important task of all, i.e., landing, the one-eyed pilot labours under a disadvantage which makes his performance less safe than if he had two eyes. Although the sample of one-eyed pilots is too small for statistical proof one way or the other, there is a good deal of reliable evidence that Mr. Tudor is quite wrong as far as landing is concerned.

"Accidents due to visual misjudgments are now such a large proportion of the landing accidents that in an effort to reduce them an extensive investigation has been made in the U.S. to find out if student pilots with poor depth-perception due to defective binocular vision were particularly prone to this type of accident. It was found that there was no correlation. No similar investigation has been done here because, if one thinks about how one controls a rapidly moving vehicle, and is possessed of a little more insight than Mr. Tudor or Dr. Baur, it soon becomes obvious that there is no reason to expect that there *should* be a correlation. The task in this case is to match the relative heading against the displacement from the desired track so that at the moment when the displacement becomes zero, the relative heading and the rate of turn are also zero. The absence of one eye can affect only *one* of these three items of information, i.e., the displacement but, since truly binocular clues to depth only operate up to distances of about 20ft in these circumstances, it follows that the absence of one eye cannot affect this particular task. More detailed information on the general problem of safety in visual landings will be found in the paper mentioned by Mr. Neumark, and also in a paper entitled *The Theory of Visual Judgments in Motion*, published recently in the transactions of the Illuminating Engineering Society.

"As practical proof of this, I would mention that we at R.A.E. have been using monocular vision on our landing simulator for the past ten years. So realistic is the presentation that most subjects forget after a few minutes that they are using only one eye, and not one of the hundreds of subjects has ever suggested that the information he got was any different from what he would have had with two eyes. This is, of course, an application of that well-known instrument, the 'monocular stereoscope,' sometimes also known as the 'monoscope.' No doubt Mr. Shackel, who recently appeared in a television programme on eye movements, would be pleased to demonstrate this to Mr. Tudor."—E. S. CALVERT, Royal Aircraft Establishment, Farnborough.



(Top) Siemens-Schuckert L.I and (lower) Ago C.I. The respective photographs are referred to in the two letters below.

German World War I Rarities

IF the description quoted by Mr. Maurice Austin is correct, the first-mentioned aircraft can only be a Siemens-Schuckert L.I of 1918, firm designation G.III (I enclose a photograph). It was the only machine with two fuselages and tractor props ever designed in Germany. Schütte-Lanz had under construction a design with a similar arrangement, but it was never completed. If the encounter happened earlier than 1918 the description must be wrong; the only twin-boom biplanes in action were the Ago C.I, C.II and C.III, plus the Otto C.I.

The second aircraft mentioned by your correspondent may be identified a little more easily as the A.E.G. The G.III with triple tail was used in addition to the usual version with a single fin.

Berlin, N.W.21. HEINZ J. NOWARRA.

[In our issue of February 7 we reproduced a reader's photographs of the A.E.G. G.I.—Ed.]

CERTAIN German World War I rarities were mentioned by Mr. Austin in your issue of January 17, and I am enclosing some photographs which depict the aircraft in question. The "machine with two fuselages with tractor screws, and a nacelle with a propeller behind" could only have been an Ago C.I, C.II or C.III, all *single*-engined pushers, but of such a form that it would have been easy for someone to have imagined the presence of tractor engines at the forward ends of the tail-booms. The C.I had a 150 h.p. Benz and a span of 15 metres; the C.II had a 220 h.p. Benz, span 18.3 m; and the C.III had a 160 h.p. Oberursel rotary.

The "small twin-engined three-seater with three rudders, etc.," was most probably the experimental version of the A.E.G. G.II, which had triple rudders; the "machine-guns . . . pointing in all directions" were doubtless a figment of a tricky memory. A less likely alternative might be the A.E.G. G.I.

Birmingham, 32. J. M. BRUCE.

An Aviation Book Club: The Snags

ONE or two of your correspondents have recently raised the question of the non-existence of an aviation book club in this country. The reason is a simple question of economics. To be successful, these days, a book club must have at least 3,000 subscribers; in other words, the publisher must be sure of a definite order of at least 3,000 copies so that he can then evaluate and calculate the costs of production of a book which he can supply to members of the club at a price lower than the original published price of the trade edition.

The question of the selection of books for an aviation book club is a very difficult one. It would be logical to suppose that a "best-seller" should be included in such a club, but the fact is that a best-seller will have appeared not only in its original trade edition, but probably in a cheap edition at about half the original published price, as well as in a book club (as a companion to books of a quite different nature); and in all probability it will be scheduled for publication in paper-back form at about 2s 6d. This means that the circulation of such a best-seller will have reached at least 250,000 people, if not more, and therefore the available market has been "creamed." Thus, there would be little point in putting many of the better aviation books in a specialist book club.

The selection of books would be confined, therefore, to those titles which have not sold well, or which are out-of-print with the original publisher. If a book has not sold well, there is obviously little point in adding it to a book club, and the problem of selection

CORRESPONDENCE . . .

of out-of-print titles would be a thorny one, for it is very likely that at least half the club members would not be interested in any one choice. I agree that the "classics" are very difficult to obtain, except by watching advertisements or by applying to the aeronautical specialist booksellers. But the fact remains that the demand is not such as to require the setting-up and printing of a complete edition.

As a member of the book trade who has discussed the question of aviation book clubs with all the leading British publishers over the past ten years, I regret to report that the possibility of an aviation book club being formed in this country is very remote *unless* a body can be found which would sponsor such a club and be able to produce books without regard to the economics of production. There is, for example, the Air Power Book Club which was recently formed in the United States, which is sponsored by the (U.S.) Air Forces Association. It intends to supply members with four books in any one year which will have a guaranteed minimum retail value of $25 (about £8 17s) for an annual payment of $15 (about £5 6s 6d). It should be borne in mind that the average retail price of a book published in the United States is roughly three times the retail price of the same book published in this country.

Perhaps readers can, through the medium of your excellent periodical, influence some trust or foundation in sponsoring or managing an aviation book club for subscribers throughout the British Commonwealth. I am sure that the publishers of all kinds of aeronautical books would be only too happy to co-operate.

London, W.1. LITERARY AGENT.

Turbulent Under Control

"CROYDON PILOT," in your issue of January 31, questions your journal's criticism of the Croydon air traffic control staff during a demonstration by Mr. Norman Jones of his little Druine Turbulent on January 1.

Your correspondent, however, is apparently (by his position at the time) unaware of the crux of the little brouhaha, which was to the effect that "if the engine had stopped you might have hit the Chipmunk at the holding point." In view of the size of Croydon, the size and manœuvrability of the Turbulent, the fact that it was flying into wind and not very high at that (by arrangement with A.T.C.) coupled with Mr. Jones's regard for his one and only neck, it seems reasonable that a laugh went up from those closest to the event. Let us be fair to the controller. He may not have intended to seem funny, equally he may not be aware of how small a space these Turbulents can operate in with safety; but, no doubt, as more of them start flying it will become obvious that a simple form of aviation is here again.

To ease Mr. Croydon Pilot's mind regarding flying over the housetops with "only" a converted car engine, I hope that he will feel relieved that Mr. Norman Jones, before flying, stressed to those present that he was not out to take the least chance and would at all times be in such a position that he could land safely back at Croydon in the event of anything being amiss during the first few flights of the aircraft. This was, of course, prudent airmanship on his part and, coupled with a well-tried engine with dual ignition operating well within its capabilities, reduced the statistical possibilities of an accident to acceptable proportions. Let me assure Mr. C.P. that the present-day ultra-light aircraft movement aims at a standard which is voluntarily higher than normal, and if at any time he cares to communicate with the P.F.A., his anonymity will be guarded and all photographs sent in a plain envelope together with all details of how and why of ultra-lights.

London, W.1. H. BEST-DEVEREUX

The History of Invention

THE review of the book *The Sources of Invention*, in *Flight* of February 7, may have given readers a misleading impression of the conclusions which Professor Jewkes, Mr. Stillerman and myself reached from our study of the history of invention in the present and nineteenth centuries. We did not conclude that the individual inventor is in danger of disappearing as a result of growing taxation: that high taxation is one of the features of the modern world which makes life more difficult for the individual inventor was only one of our conclusions.

The chief of these were that there has been no fundamental change in the methods by which inventions are made in the present century, compared with those of the past; and that the individual inventor still has much to contribute. In the histories of the 61 recent inventions which we studied it was found that the individual inventor had played the major rôle in more than half. Of the three aeronautical inventions among the 51 on which we published case histories, the jet engine and the helicopter we considered to be the work of individual inventors, who also contributed much to the long-range rocket.

We thus were led to the conclusions that it is misleading to consider that technical progress in the present is on an essentially different basis from that in the past, and that dependence on organized research establishments as the chief source of inventions is undesirable. The large industrial research laboratory does not seem a particularly suitable environment for the encouragement of invention, and the use of large teams is no way to produce one. As the late Sir Alexander Fleming said, a team is fine when you have something to go on, but about the worst way of starting when you have nothing to go on. Industrial research laboratories thus tend to be better suited to development than invention, though some have managed to provide a congenial home for an inventor.

The problem of encouraging technical progress seems to us more complex than most recent discussions of the subject suggest; the expenditure of large sums of money on organized research institutions could become self-defeating. It seems to be an innate characteristic of institutions that they become resistant to new ideas, especially if they arise outside them. (Farnborough around 1930 gives some examples of this.) Helping the inventor is complicated by his essential individualism, his often "difficult" characteristics, and the existence of so many charlatans. But it does seem that technical progress could be speeded by a more sympathetic attitude to the individual inventor than that at present existing in Britain, and a greater willingness on the part of companies to seek for and fertilize the possible grains of wheat amongst the chaff with which inventors present them. The Government also could assist, if it were prepared to risk funds on the development of inventions as well as on slightly less speculative projects like aero-engines. It has to be remembered that the early development of an invention is the cheapest phase; whereas it cost Whittle £20,000 to show that the turbojet would work, the Ministry of Supply spent £11,000,000 on the development of the Bristol Proteus.

Walton-on-Thames, Surrey. DAVID SAWERS

[*The Sources of Invention* is published by Macmillan, price 31s 6d—ED.]

"Selling" the Industry

THE suggestion by Mr. Hardy [January 31] that the aircraft industry should "sell itself to the British public in general, and to the Government in particular" is one which would substitute the invariably spurious claims of the advertising business for those values which are obtained by solid, untrumpeted achievement. Is it necessary for the industry to join the unending battle to gain the fickle admiration and confidence of the public?

The money that can be spared should be used for scholarships and endowments, which will help to create the aircraft of the future. We cannot afford to squander our resources on complacent appraisals of our past successes.

London, N.19. D. E. RAYNER.

Slip on the Cresta

IT is not often one can find a mistake in your excellent magazine, although the one I am going to point out is entirely unconnected with aeroplanes.

In your issue of February 7, at the bottom of page 191, I cannot allow you to show an air vice-marshal with so much drift on! The picture is, in fact, of myself and was taken by a *Times* photographer during the morning of the Commonwealth Championships on the Cresta. This picture was later, I believe, printed in *The Times*.

Fontainebleau, France. C. N. C. MITCHELL, F/LT.

Historical Riposte

I AM sorry that your correspondent Mr. Cain (February 7) resents my anonymity; but I cannot give my name because, like the original Cain, I am not abel.

Walton-on-Thames, Surrey. BELTANE.

FORTHCOMING EVENTS

Feb. 21. Institute of Navigation: "Air Search and Rescue Problems," by A. Cdre. R. T. Gething.
Feb. 25. R.Ae.S.: Guided Flight Section: "Guided Flight Trials," by R. W. Boswell.
Feb. 26. R.Ae.S.: Presidential Address by Sir George Edwards.
Feb. 26. British Institution of Radio Engineers: "Dectra: A Long Range Navigation Aid," by C. Powell.
Feb. 26. Kronfeld Club: "The Necessity for Aviation Insurance," by J. Risley-Prichard.
Feb. 27. Aerodrome Owners Association: Annual General Meeting.

R.Ae.S. Branch Lectures (to Feb. 27):—
Feb. 21. *Birmingham*, Branch President's Night. Feb. 26. *Hatfield*, "Fairey Delta 2," by R. L. Lickley and L. P. Twiss; *Preston*, "Problems Associated with Non-Metallic Materials in Aircraft," by N. J. L. Megson and E. W. Russell. Feb. 27. *Bristol*, "Servicing of Civil Aircraft," by I. Gregory; *Cambridge*, "Some Aspects of Aircraft Production," by H. Povey; *Yeovil*, Third Henson and Stringfellow Memorial Lecture, by S. G. Hooker.

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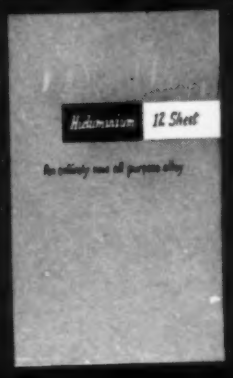

Hiduminium

Aluminium

Development testing of a Rolls-Royce Tyne engine.

Progress in turbine engines calls for ever higher operating temperatures and creates incessant demands for more advanced heat-resisting materials. These demands are being met in every British aero gas turbine by the Nimonic Series of Alloys which retain great strength even at red heat. In the Tyne turbo-prop, which is to power the new Vickers Vanguard airliner fleet, Nimonic Alloys are specified for the turbine rotor blading and many other parts in contact with the hot gases.

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ALLOYS

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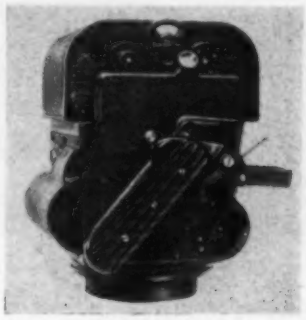
TGA HTA28

THE INDUSTRY

P.V. Camera Success

ORDERED by the Ministry of Supply on behalf of Air Ministry, a new universal air camera designed by the Williamson Manufacturing Co., Ltd., Litchfield Gardens, London, N.W.10, has been designated F117. Trials were made last year in close co-operation with Coastal Command. Williamsons manufactured the camera as a private venture, feeling that there was a need for 4½in by 4½in aerial photographs and that a replacement was needed for the well-known F24.



Williamson F117 camera.

Specification details include: number of exposures, 110; film capacity, 50ft by 5in (detachable magazine); international standard 5in spools; patented two-blade between-lens shutter; speeds, 1/400th, 1/250th, 1/100th, and 1/50th; lens, high-resolution Ross Xpres 6in f/4.5; maximum operating speed, two exposures per second.

The camera will be available initially in four versions: F117A, manually operated hand-held (general-purpose air camera); F117B, electrically operated hand-held (suitable for maritime reconnaissance, helicopters, etc.); F117C, electrically operated in fixed mounting, controlled by standard intervalometer (general purpose reconnaissance, vertical, oblique or forward facing); and F117D, electrically operated in fixed mounting, controlled by standard intervalometer with image-movement compensation (high-speed medium- and low-altitude vertical photography).

These variations are obtained by replacement of units on the basic design, which can be used with existing intervalometers. Williamsons state that overseas air forces have shown interest in the F117 design; they are now completing development of the F117D and expect that there will be further variants.

English Electric Scholarship Scheme

UNDER a new university scholarship scheme inaugurated by the English Electric Co., Ltd., twenty scholarships, each worth £450 p.a., will be awarded each year to young men with qualities fitting them for senior posts in the engineering industry. The scheme will become operative for the academic year 1958-59.

Successful candidates will read for an honours degree in any subject allied to advance technology at any university in the United Kingdom, their scholarships being tenable for three years. Training will be divided into three parts: a period at a university, industrial training with one of the companies in the English Electric Group, and a salaried staff appointment for two years. This will qualify successful trainees for corporate membership of the appropriate professional institution.

Any boy of British parentage who qualifies for entry to a university honours-degree course will be eligible. Further details may be obtained from Mr. G. S. Bosworth, Central Personnel Services, Marconi House, 336-7, Strand, London, W.C.2. Headmasters of schools are being notified of the scheme.

Mr. A. F. Johnson

WE are sorry to learn that Mr. A. F. Johnson, C.B.E., D.F.C., who was engaged on public relations and general publicity work for the guided weapons division of English Electric from January 1955, has died after a short illness.

Mr. Johnson, who was born in September 1908, joined the R.A.F. in 1924 and remained in the Service until his retirement in 1954. In 1941, as a squadron leader, he commanded No. 203 Sqn. in the Western Desert and was awarded the D.F.C. for his part in operations. Two years later he was appointed Senior Air Staff Officer at Headquarters, East Africa, and for his work there was appointed C.B.E.

After the war, as a group captain, he was appointed Deputy Director of Manning at the Air Ministry, and this appointment was followed by a tour as Group Captain (Training) at Bomber Command. His last post in the R.A.F. was Staff Officer i/c Administration at H.Q., 23 Group. Mr. Johnson leaves a widow and one son.

Modern Block

ILLUSTRATED here is the new multi-storey, 70,000 sq ft air conditioned and temperature-controlled factory-block addition to R. B. Pullin and Company's Phoenix Works at Brentford, Middlesex.

The new Pullin extension.

Designed for highly-specialized gyroscopic, electrical and electronic precision-instrument production, the new block is air-conditioned by a system described as "probably unique in this country or elsewhere." The whole of the circulation ducts are contained within the reinforced-concrete hollow-column framework and are not visible either inside or outside the building. Another noteworthy feature is the ring-main electrical system, whereby 500 kW copper busbars are carried up two vertical ducts, one at each end of the building. These are linked at each level by horizontal busbars carried within suspended ceilings over central circulating corridors. Each section can be isolated by main switchgear housed in the vertical ducts. These ducts also carry heating, gas, water, air-lines and high/low voltage supplies, thus keeping the interior of the building free from dust-collecting pipes and ledges.

A system of "graded" artificial lighting ensures even illumination under varying conditions.

Other news from R. B. Pullin (see above) concerns a new appointment, that of Mr. E. Lloyd Thomas as chief development engineer. He was with Plessey during the war, working mainly on C.R.D/F. equipment; then with Sperry, on weapon-guidance systems; and latterly with Short Bros., where, as chief research engineer, he established a team for work on automatic control systems for aircraft and missiles. He has also been responsible for the development of the Short analogue computer.

IN BRIEF

Maj-Gen. J. Charles Haydon, C.B., D.S.O., O.B.E., has been appointed Board representative of the Miles group of companies, whose headquarters are at Shoreham Airport, Sussex. The company states that he will represent the directors on all matters referred to him.

* * *

The Self-Priming Pump and Engineering Co., Ltd., of Trading Estate, Slough, Bucks, will in future be known as SPE Co., Ltd. The company's London office is now at 20/26 Lamb's Conduit Street, W.C.1.

* * *

A new director, Mr. George C. Fairbanks, M.I.P.E., has been appointed by Elliott Brothers (London), Ltd. Mr. Fairbanks is a deputy general manager of the company and has held various senior executive positions since the war, including directorships of the Fisher Governor Co., Ltd., and Bristol's Instrument Co., Ltd., both Elliott subsidiaries.

We regret to record that Mr. John H. Cork, manager of the aircraft laboratories of Vickers-Armstrongs (Aircraft), Ltd., Weybridge, died suddenly on February 9 at the age of 55. He had held this position for some 20 years and the work of his department embraced metallurgy, chemistry and electrical, mechanical and structure engineering. He was intimately concerned with the current structural engineering of the Viscount, Valiant and Vanguard aircraft. Before joining Vickers in 1923 Mr. Cork was at R.A.E.

SERVICE AVIATION

Royal Air Force and Naval Flying News

Forming a gracious study against the pattern of Australian countryside, this Convair Metropolitan 440 of the R.A.A.F. has been used by the Queen Mother on all her Australian journeys except the Adelaide - Perth leg. The R.A.A.F. has two of these V.I.P. Metropolitans at Canberra.

Operation Quickstep

FROM R.A.F. stations Lyneham and Abingdon, 500 troops of the 24th Infantry Brigade and their equipment were last weekend flown to Tripoli in Libya by Comets, Hastings and Beverleys of Transport Command in an Army-R.A.F. mobility exercise known as Operation Quickstep. A full description of its execution will be published in next week's issue.

White Paper Changes

UNDER the terms of the Defence White Papers published on February 13, the R.A.F. recruitment ceiling has been fixed at 135,000 (its strength at the end of the year 1957-58 will be 182,000) and increases in pay and allowances have been announced. These affect both officers and O.R.s. The latter are to receive an increase in weekly pay of 14s, 17s 6d or 21s (depending on their length of engagement), while junior officers will receive proportionately larger increases than those who are in the higher ranks. These increases are to come into force early in April. (Other air aspects of the White Paper are dealt with on page 230.)

Catering Directorate

FORMED in 1949 and responsible for providing millions of pounds' worth of food annually for R.A.F. stations throughout the world, the R.A.F. Deputy Directorate of Catering has now been raised to the status of a Directorate within the Directorate-General of Equipment. Its first Director is G/C. W. H. Canniford, head of the former Deputy Directorate since its inception and associated with catering ever since he enlisted in the R.A.F. in 1923.

Dental Appointment

FOR the past year assistant to the Director of R.A.F. Dental Services, G/C. H. Keggin has now taken up the appointment of Deputy Director of Dental Services, with the acting rank of air commodore. His previous posts have included those of P.D.O. with 2nd T.A.F. (from 1954 to 1956) and subsequently with Flying Training Command.

R.A.F. Rugby Victory

BY a goal, two penalty goals and a try to one penalty goal—14 pts to 3 pts—the R.A.F. beat the Royal Navy at Twickenham last Saturday in the first match of this season's Inter-Service Championship. Much the best play came in the second half, when Sandstrom scored two fine tries for the R.A.F., who were markedly stronger behind the scrum. The first (converted by Rutherford) came after Brace had deceived the Navy defence with a scissors movement, and for the second Sandstrom ran all the way from his own "25." Rutherford also kicked two penalty goals, and Mainwaring replied with one for the Navy.

Home-made Cinema

AIRMEN at R.A.F. Schleswigland in North Germany have built themselves a 120-seat cinema in a disused N.A.A.F.I. canteen. Seats which had been scrapped from another cinema by the R.A.F. Cinema Corporation were fitted and re-upholstered and S.A/C. L. D. Craig, a carpenter who works on the airframes of Mosquitoes operating from the station, built the proscenium and ticket-booking office and also a confectionery and cigarette kiosk. P/O. P. Dixon, of No. 5352 Airfield Construction Wing, kept an eye on the amateur builders and supervised the laying of the sloping floor.

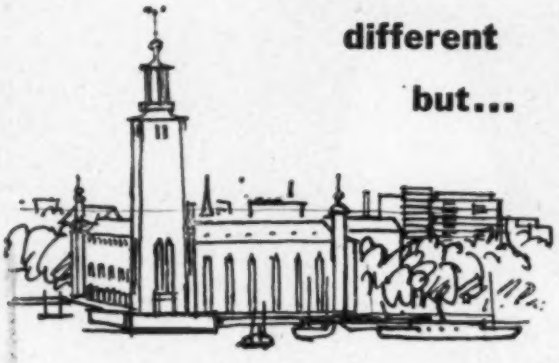
Work began last summer, and was completed recently when 16 mm projectors were installed. The cinema was then formally opened by Mrs. Miller, wife of S/L. H. Miller, the station commander.

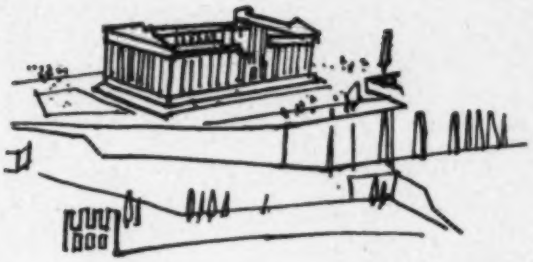
No. 1 S.F.T.S. Reunion

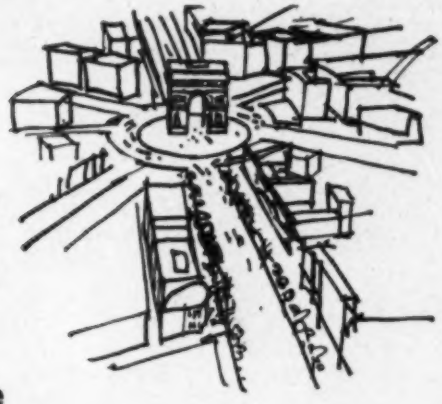
A REUNION of No. 1 S.F.T.S. (1), Ambala, is to be held at the Chevrons Club, 3 Dorset Square, London, N.W.1, on Saturday, March 15. This will be the unit's 11th reunion, and details may be obtained from S. Booth, Esq., 28 Dene Road, New Southgate, N.11.

Fit subject for a latter-day Turner, these R.N. Sea Hawks make a dramatic picture (reminiscent of the great artist's "Rain, Steam and Speed") as they fire their starter cartridges aboard H.M.S. "Ark Royal" recently prior to taking-off for a fly-past over Malta to accompany a squadron of Gannets from H.M.S. "Eagle," which are being based there.

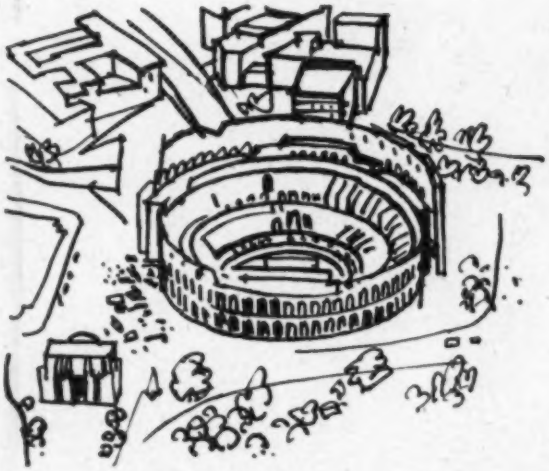
The landmarks may be different but...







the service is the same



As air travel reaches out to all the countries of the world, so must the services which keep the aircraft flying. The BP Aviation Service is international; at hundreds of different airfields it supplies the essential fuelling and other services on which modern air travel depends.

AVIATION BP SERVICE

serves aviation well

The international aircraft fuelling organisation of
The British Petroleum Company Limited

News of TACA Viscount Experience

Ricardo H. Kriete, President of TACA International Airlines, announced recently in San Salvador that in the first six weeks of operation over its routes the Vickers Viscount has shown encouraging traffic trends.

'On certain routes the load factor has been as high as 86%. The load factor over all routes on which the company operates the Viscount schedules has been 73%. Passenger reaction in our area has been most enthusiastic for the new jet-prop aircraft', said Mr. Kriete.

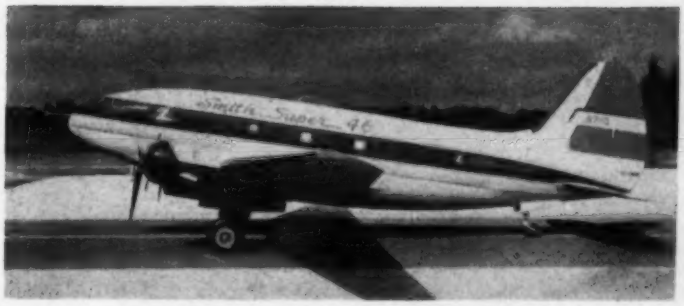
Passenger-appeal is often considered intangible. In the Vickers Viscount it is a conscious feature of design, based on experience. Peace of mind as well as physical comfort have been translated into practical terms, and independent studies have shown that Viscount passengers experience less fatigue than other air travellers. Built-in ease of maintenance speeds turn-round and avoids the irritation of airport delays.

All the passenger-appeal features in the new Viscount 810-840 are backed by experience based on over a million airline hours with earlier Viscounts already in service with 27 airlines. As the world's favourite airliner, the Viscount keeps passenger loads high, costs low and balance sheets healthy.

There is no substitute for experience

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

TGA AT 565



Now undergoing C.A.A. inspection and test at Miami International Airport is this modification of the C-46 by L. B. Smith Aircraft Corporation. Known as the Super 46C, the modified aircraft includes Pratt and Whitney R-2800 C-type engines. L. B. Smith's first modified C-46 will be delivered to Varig.

CIVIL AVIATION

D.H.121s FOR B.E.A.: NEARING THE MOMENT OF TRUTH?

IT is still not 100 per cent certain that a contract for 24 D.H.121s, with an option on a further 12, will be signed between Airco and B.E.A. The Government announcement in Parliament last week contained what appeared to be a possible loophole. The Minister of Transport said:—

"The Corporation will open negotiations this week with a new company in which de Havillands, Hunting Aircraft, and Fairey Aviation will participate. Rolls-Royce will develop and manufacture the power plant. The Government will wish to be satisfied that the whole project will be developed and manufactured as a private venture by the companies concerned."

But there now seems little doubt that the way is clear for de Havilland, with their Hunting, Fairey and Rolls-Royce partners, to get busy with detail design and engineering of the D.H.121. The programme, which calls for deliveries to B.E.A. in the early part of 1964, will be a tight one; six years from the start of detail-design to passenger-service is one year less than the generally accepted time-scale for a new commercial airliner, and the 121 programme is already months delayed.

The designers of the 121 are not yet ready to talk about their project, presumably because they feel aware—as in the early Comet days—of mounting American competition. It is probable also that de Havilland and Rolls-Royce still have open minds about certain aspects of the design, in particular the details of the triple R.B.141 powerplant installation. This perhaps explains why only one view of the aircraft (*Flight*, February 7) has so far been released.

There is, therefore, little to add to what has already been published, except to clear up one or two misconceptions about the rôle of this kind of aeroplane. It has always seemed pretty clear (*Flight*, September 6, 1957) that B.E.A.'s requirement is for a jet aeroplane quite different from any other breed of jet on paper or in prospect. To compare the D.H.121, or the Bristol 200, with the Boeing 720 (a 185,000 lb to 200,000 lb transport) or with the similar-sized Convair 880, is to miss the point. No doubt sales of those aeroplanes will overlap into the D.H.121 market, just as they have overlapped the DC-8 and Boeing 707 market. But by no stretch of the imagination, or unstretching of their structures and engines, can those aircraft be declared the optimum choice for short-haul routes. Although to think of the 121 as a Viscount replacement would not be quite right, such a comparison puts the 121 concept—and its technical difficulties—into perspective. It would certainly be more reasonable to compare the 121 with a Viscount than it would with a 720 or an 880.

If this is accepted, it follows that the way to start designing a jet for very short-haul work (i.e., not more than 1,000 miles maximum stage length with full payload and reserves) is to keep it small and to keep it light. This is not easy if seating for up to 100 passengers is required: but the tenet of short-haul economics, particularly for jets, is large revenue-earning capacity. So everything must be done to keep down weight—hence power, hence fuel, hence costs.

If such an aeroplane can be achieved, it should sell, because the cost-curve of no other jet can approach it over the short stages. Sights must first be set on good short-haul economics, because—with the one notable exception of the Caravelle—this is something which no other jet can achieve in competition with turboprops.

Having achieved good short-haul economics (and made B.E.A. happy), sights may then be raised to stretch the range up towards medium-haul requirements—if the market exists, and if it can be done without becoming involved in a different class of aeroplane. Jets are not inherently as flexible as turboprops: an additional 750 or 800 miles of range with the same payload might easily result in an aeroplane far removed from the original "small and light" ideas. One cannot, in the classic range-stretching way, just increase wing span to get more L/D and more fuel without severe accumulative penalties in weight, power and consumption.

There is a strong view (which according to rumours is shared by Douglas) that the big market is for a jet "optimized" for short-hauls. One feels that D.H. know this, and that from their jet transport experience they know just what can and cannot be done in the way of stretching.

In other words, it is untrue to say that a jet designed to B.E.A. requirements will not fill the needs of others. The market is in the short ranges. If range can be stretched to meet medium-haul requirements without spoiling the aeroplane, then this will obviously be done.

J. M. R.

B.O.A.C IN THE MIDDLE EAST

THE current negotiations between B.O.A.C. and Arab Airways are a reminder of the Corporation's considerable interests in the Middle East. Over the past decade B.O.A.C. have steadily expanded their connections in this region and now appear to have over £1m. invested in seven airlines—Aden Airways, Arab Airways, British International Airlines, Cyprus Airways, Gulf Aviation, Middle East Airlines and T.H.Y.—and in the Mid-East Aircraft Service Company at Beirut.

Aden Airways were the first B.O.A.C. associate in the Middle East, having been formed in October 1949 as a wholly owned subsidiary to operate a fleet of six DC-3s. The following year a 23 per cent share in Cyprus Airways was obtained by buying one half of B.E.A.'s shareholding, and in 1951 a 51 per cent holding in Gulf Aviation was acquired. This airline had only been founded the previous year and was operating local services in the Persian Gulf. The next company in which B.O.A.C. became interested was Arab Airways. As fully described in last week's *Flight*, a 49 per cent share in this Jordan airline was acquired by Aden Airways in 1953.

None of these investments compared in magnitude with the Corporation's purchase in 1955 of 48 per cent of the share capital of Middle East Airlines. In 1949 PanAm had received a 36 per cent share in M.E.A. in return for three DC-3s. By 1955 M.E.A. wished to acquire four-engined transports but could not reach agreement with PanAm. Under a new contract with B.O.A.C., the Lebanese company was enabled to buy Viscounts. The latest B.O.A.C. agreement also involves Viscounts, a credit for £1½m. having been extended to the Turkish national airline, B.O.A.C. receiving a six per cent share in T.H.Y.

B.O.A.C.'s other interests in the Middle East include a 59 per cent share in M.A.S.C.O. (the balance being held 30 per cent Hunting-Clan, 5 per cent by M.E.A. and 6 per cent by others). Another subsidiary, British International Airlines, operate charter flights in the Persian Gulf and since 1953 have had a management contract with Kuwait Airways. Defunct management agreements have been negotiated with Iraqi Airways and Eagle Airlines (a predecessor of Iranian Airways).

Since 1955 all the Corporation's investments in the Middle East (excluding Cyprus Airways, M.A.S.C.O. and T.H.Y.) have been transferred to a single holding company, Associated British Airlines (Middle East), Ltd., owned 80 per cent by B.O.A.C., 15 per cent by B.E.A. and 5 per cent by Hunting-Clan. A clear picture of each subsidiary airline's financial condition cannot be obtained now that the various accounts are consolidated, but even when the accounts were shown separately it was difficult to separate the figures for the subsidiaries from those for the parent Corporation.

The main item in B.O.A.C.'s portfolio, M.E.A., has lost heavily in the last two years. But this has been a period of costly reconstruction, and the immediate prospect is favourable. M.A.S.C.O. has also lost heavily to date, but once firmly established this company should also become a profitable venture. Arab Airways have shown consistent losses, while the other airlines usually have shown marginal profits.

A Sud Alouette 2 has been placed in regular service at Sestriere, Northern Italy, to cater for winter-sports traffic. A ten-minute flight costs 5,000 lire (just under £3).

CIVIL AVIATION . . .

Q.E.A. ORDER OTTERS FOR NEW GUINEA

QANTAS are to replace the two Catalinas and four Beavers used on their internal network in New Guinea by four Otters. The first, to be delivered from Canada in May, will be fitted with floats as well as retractable nose- and main-wheels. This machine, based at Port Moresby, will take over the services to Papua, New Guinea and New Britain previously operated by Catalinas. The remaining three aircraft, all landplanes, will be delivered in June and July, one joining the amphibian at Port Moresby, the other two replacing the Beavers stationed at Lae.

De Havilland have purchased the four Beavers from Q.E.A. in part exchange for the Otters and expect to re-sell these aircraft to another Australian airline for outback operations.

APRON REQUIREMENTS FOR THE JETS

ALMOST two years ago I.A.T.A. published a document on *Airport Buildings and Aprons*. While this survey looked back over the experience of piston-engined aircraft, their latest pamphlet, *Apron Requirements for Turbine-powered Aircraft*, is an effort to peer forward to the new set of conditions that will develop in the next few years.

This 57-page survey is divided into four sections, dealing with general considerations, apron systems and requirements, fixed servicing installations and apron load-handling facilities.

The first section describes the problems of blast, heat, fumes, noise, debris and fuel spillage, discussion being limited to parking, start-up and manœuvring. Problems of take-off are not examined.

The next section considers the three main types of apron system: stands situated immediately adjacent to terminal building; "fingers" in the form of piers, tunnels or fenced walkways; and "the open apron system," whereby stands are situated away from terminal buildings and no "protrusions" extend into the apron area. Working on the basis "that manœuvring of turbine-powered aircraft on the apron should be carried out under the aircraft's own power," I.A.T.A. concludes "that open systems are undesirable and that where aircraft cannot be parked on stands immediately adjacent to the terminal building, the pier finger system best meets the airline requirements."

It is acknowledged that the substitution of mobile servicing equipment by fixed installations will usually be justified only in the case of a few major services. But stress is laid on the fact that "successful operation of turbine-powered aircraft hinges on maximum utilization and consequently on short transit stops and quick turn-arounds." Fixed installations will frequently be necessary to avoid airport congestion.

The growing size of modern airliners is already causing anxiety about the time taken to load and unload, and the advent of aircraft carrying over 100 passengers will bring further embarrassment unless loading techniques are streamlined. In the absence of mechanical conveyance systems, "it is important that a standard routeing pattern be agreed, provided such a routeing is as direct as practicable." Passengers should be able to proceed to the aircraft individually, possibly making use of movable gangways or moving sidewalks ("horizontal conveyer belts"). Passenger-carrying vehicles are considered "to be even more unsuitable for turbine-powered aircraft operations than for conventional aircraft." Cargo loading calls for "mechanical conveyance systems."

All these requirements, logical as they are for the airlines, have two things in common: first, they will be expensive; second, they will not be paid for by the airlines, but by airport authorities (unless landing and handling charges are raised substantially). These authorities, having been presented as a *fait accompli* with the problems of jet operation by the world's airlines, must surely raise their eyebrows to read that "it cannot be emphasized too strongly that early and continuous consultation is imperative between the airlines concerned and the authorities responsible for the planning of the airport's buildings and aprons."

ROOM AT THE INN

IN a recent White House meeting with President Eisenhower's Committee on Facilitation and Promotion of International Travel, Mr. Juan Trippe, President of Pan American World Airways, claimed that the major barrier blocking the growth of international travel was lack of hotel accommodation.

To the travelling public this shortage of suitable hotel space seems inexplicable. Demand for accommodation is clearly so strong that there should be little difficulty in attracting the necessary capital to finance hotel construction—or so it appears on first sight. But there is a widely held belief that inflation has so increased the cost of building and of running an hotel that it has become virtually impossible to break-even if allowance is made for seasonal variations in demand for accommodation.

This belief is being challenged in this country by the building trade and by professional architects who challenge estimates based on assumptions of £3,000 per bedroom when, as they point out, new hotels such as the Dover Stage are being constructed for £2,500 per room.

That technological developments in this industry are not being entirely ignored is shown by a recently announced plan to construct a new £600,000 hotel on a three-and-a-half acre site on the Bath Road close to the London Airport north passenger terminal. Sponsored by a Canadian company, Seaways Hotel, Ltd., it will cover threequarters of an acre, will have 200 bedrooms with provision for a further 83, and should be completed in 1960.

The tail units of three Britannias—a 102 on each side of a 312—seen protruding through the specially designed hangar doors at B.O.A.C.'s engineering base at London Airport.

Lockheed's second Electra (top), showing a new fuselage striping design, was recently airborne for nearly two hours. While the Electra has yet to be seen outside California, the Russian Tu-104 has visited many capitals of the world, and is seen in Paris in C.S.A.'s colours.

A NEW AIRLINE IN INDIA . . .

SINCE nationalization of India's air transport in 1953, the nation's independent airlines have been limited to non-scheduled operations and have been denied the long-term security necessary if new aircraft are to be purchased. Recent indications in the Indian Parliament are that the growth of private airlines is now to be encouraged, and the suggestion has been put forward that associate agreements, on the lines of British experience, be drawn up to allow private companies to offer complementary, rather than supplementary, services in addition to those already offered by I.A.C. and Air-India.

The first response to the changing official attitude has been that the private airlines have begun to show an interest in new aircraft. Shortly before Christmas Kalinga Airways were testing a Noratlas.

Now four of the leading independent carriers—Kalinga, Indamer, Jamair and Darbanga—have formed a single company with a total fleet of fifteen DC-3s and combined assets valued at about Rs. 3m (£225,000). This new company, probably bearing the name Kalinga, will concentrate on non-scheduled services, a particularly remunerative market being the carriage of monkeys (exported for medical research). But there are also prospects for scheduled routes, Kalinga already having been recommended by the Indian Government to operate between Tibet and West Bengal. Final approval for this service has yet to be received from the Chinese authorities in Peking.

. . . AND IN SIERRA LEONE

AS forecast in *Flight* (January 17) a new airline has been established in Sierra Leone to operate internal services from Freetown. The main service will extend from Freetown's nearest airport, Hastings, to Magburaka, Bo, Kenema, Daru and Port Loko. Another service will shuttle between Hastings and Lungi, the airport used by trunk carriers.

Sierra Leone Airways will use three eight-seat D.H.89 Rapides. These aircraft are the Mk 4 version fitted with Gipsy Queen II engines and variable-pitch propellers. Lightweight radio equipment includes Sunair H.F. R/T. communications transmitter/receiver unit, and Lear AFDR. 14C.

Sierra Leone Airways will be managed by West African Airways on behalf of the Sierra Leone Government.

INCIDENT REPORT

"THERE was no evidence of negligence on the part of the captain or of the first officer," states the report of the Inspector of Civil Aviation Accidents of the Irish Department of Industry and Commerce on an incident involving Aer Lingus Viscount 707, EI-AFW *St. Brigid*. The aircraft ran off the runway at Dublin airport on September 24 last year.

EI-AFW was taking off for London, carrying 52 passengers and a crew of four, when a defective fuel-pump overspeed-governor caused fuel starvation to No. 3 Dart engine. The take-off was abandoned after 2,400ft of runway had been traversed. Incomplete closure of the throttles due to local stiffness in the movement of the levers against the friction-damper (which was on) caused the propellers to continue to develop thrust. Thus the aircraft could not be retarded by wheel-brakes alone, and, in any case, their effectiveness was reduced by the very wet surface of the runway. Lowering of the flaps by the first officer was the only course of action left open as the aircraft left the runway and ploughed its way through soft ground, nose first.

None of the passengers or crew was injured and the aircraft was back in line-service within eight weeks.

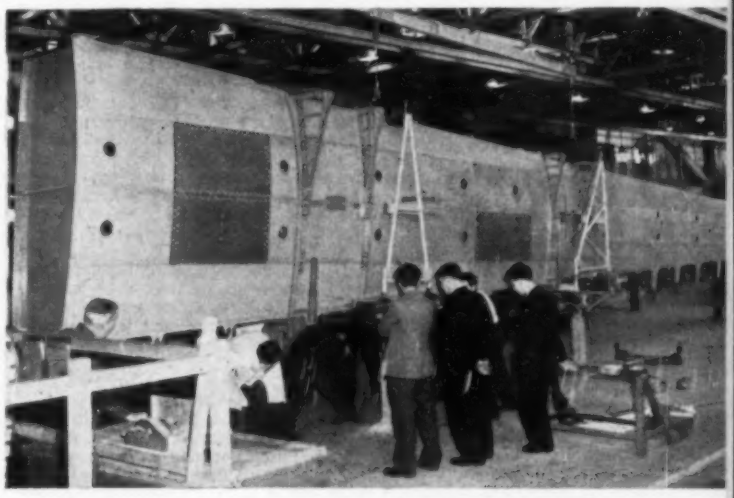
AGUSTA'S PISTON TRANSPORT

AT a time when the tide of fashion is running in favour of the turbine, it is remarkable to find a company that is prepared to stand by its economic evaluation of the piston-engined transport. Costruzioni Aeronautiche Giovanni Agusta of Gallarate are canvassing the AZ-8, a new four-engined 22/26-seat aircraft, designed "for operating on small and medium-range routes where reduced traffic service, or traffic of an intense but often sporadic nature, is often encountered."

The long, narrow fuselage is of conventional monocoque design. Total volume is 1,980 cu ft, of which the passenger cabin contributes 980 cu ft. Only two rows of "armchairs" are provided, each seat having its own window. The wing comprises a 43ft 4in centre-section and two 20ft 2in outer sections, aspect ratio being 9.78 and total wing area 719 sq ft. The conventional tricycle undercarriage is hydraulically retracted and is designed for unprepared runways (diameter of main tyres and nosewheel tyres being 29in and 22in respectively, but 22in mainwheel tyres can be fitted for operating under more sophisticated conditions). The area of the single monocoque fin is 41.5 sq ft, the rudder accounting for 31.7 sq ft. Tailplane area is 71.7 sq ft and elevator area 43 sq ft. Four Alvis Leonides 502/5 (take-off power 540 h.p. maximum r.p.m. 3,000, dry weight 850 lb) are fitted with de Havilland constant-speed feathering propellers. In the event of one engine failing, the AZ-8 can still take off with full load, and can climb to 19,700ft with three engines. Maximum economy is achieved over stages of 375 to 500 miles.

Dimension and weights: Overall length, 63ft 9in; overall height, 21ft 8in; wing span, 83ft 8in; wing area, 719 sq ft; cabin length, 32ft 2in; cabin height (internal useful), 6ft 3in; cabin volume, 980 cu ft; normal number of cabin seats, 22 to 26. Empty weight, 15,650 lb; maximum weight, 24,900 lb; max. disposable load, 9,250 lb; wing loading, 34.6 lb/sq ft; power loading, 11.50 lb/h.p.

Performance: Max. speed at 1,750ft, 266 m.p.h.; at sea level, 260 m.p.h.; at 9,850ft, 256 m.p.h. Cruising speed at sea level, 212 m.p.h.; at optimum altitude of 9,850ft, 230 m.p.h. Service ceiling with four engines, 25,900ft; with three engines, 20,000ft. Climbing speed at sea level, 1,110ft/min; at 9,850ft, 995ft/min. Take-off distance with four engines at sea level: field length, 1,345ft; to 50ft, 1,770ft.



The first complete Vanguard wing box to be finished at Vickers' Weybridge works. In the upper surface can be seen the tank access panels and the apertures for the transistorized Pacitron tank gauges.

Here is the first of three Vickers Viscount 769s for the Uruguayan airline P.L.U.N.A. Another Latin-American airline has also, as recorded last week, been added to the Viscount order-book—the Nicaraguan airline L.A.N.I.C.A., who have taken delivery of two ex-Lloyd Aero Colombiano aircraft.

CIVIL AVIATION . . .

NEW LIGHT ON CAPITAL'S 880s

THE surprise announcement of Capital's purchase of up to 15 Convair 880s (*Flight*, January 31) has now been described by National Airlines' lawyer as "either phony or illegal," according to an American *Aviation Daily* report.

This allegation was made during the course of C.A.B. hearings on a domestic-route case. The case in question was not, it so happened, the long-drawn-out C.A.B. investigation into which airline shall become the third carrier to serve the Great Lakes-Florida route. This route, which links the Miami holiday area with big Great Lakes cities like Buffalo and Detroit, is already served by Delta and Eastern. For a long time Capital Airlines have been after this route, which would provide an economic balance for their existing short-haul network. The award to Capital appears to have depended upon C.A.B.'s being satisfied that the company had suitable equipment; and it was probably no coincidence that Capital's deal with the General Dynamics Corporation was announced at a critical point during the C.A.B. hearings.

National Airlines are one of the carriers who also hope to be awarded this lucrative route, and their lawyer's allegation must be judged in this light. Nevertheless, his cautioning of the C.A.B. that the Board was "under a duty to find out if there is actually an agreement" does not seem unreasonable. The arrangement is certainly a mysterious one.

An *Aviation Week* report of the Capital-General Dynamics Corporation Convair 880 financing arrangement includes comments from Mr. Lambert J. Gross, financial vice-president of General Dynamics. He said that there was "nothing unique or dramatic" about the agreement with Capital. As for possible financing arrangements between manufacturer and customer, Mr. Gross apparently considers such a trend "unlikely." The capital requirements of the aircraft industry itself are so great, he pointed out, "we couldn't go very far down that road."

Convair's reply to the "phony or illegal" allegation was that General Dynamics has found outside interests willing (1) to finance Capital's purchase of CV-880s, (2) to re-finance the Viscounts, (3) to finance the lease of interim equipment [possibly new L.1049Hs from Lockheed], and (4) to help Capital dispose of their long-unsaleable L.49 Constellation fleet. *American Aviation* believe that the banking interests involved are Chase Manhattan and the First National City Bank of New York.

SABENA WANTS CARAVELLES

THE list of major European airlines which have not yet ordered short-haul jets is now further reduced by the Sabena order for eight Caravelles. Those remaining on the list—Swissair, K.L.M., Iberia, Lufthansa and Alitalia/L.A.I.—find themselves placed in a position where short-haul turbine aircraft are indispensable on competitive grounds alone. Any delay in ordering aircraft now will mean that rival carriers will be stealing a traffic lead during the next two or three years.

Sabena seek to raise the necessary funds from the Belgian taxpayer. A draft bill has been tabled in the Belgian Senate proposing that Sabena's capital be increased from its present level of B. Fr. 500m. (£3.6m.) to B. Fr. 700m. (£5m.) by 1959 and B. Fr. 1,000m. (£7.1m.) by 1960. Furthermore, the State is being asked to guarantee loans up to B. Fr. 4,000m. (£28.6m.). At present Sabena's loans amount to about B. Fr. 2,000m. (£14.3m.).

Sabena plan to purchase, in addition to Caravelles, 12 Friendships from Fokker.

BREVITIES

IN 1957 the U.S. domestic scheduled airlines overtook the railways as America's biggest inter-city passenger carriers. They flew an estimated 25,500m passenger-miles: the railways achieved an estimated 21,700m—a fall of seven per cent on the 1956 figure.

* * *

Convair are reported by *Aviation Daily* to have a 100,000 lb, twin-jet (possibly ducted-fans) short-haul jet airliner in prospect.

* * *

American Airlines' order for medium jets is said to be imminent: between 15 and 25 Boeing 720s or Convair 880s will be involved.

* * *

South African Railways' budget for 1958-1959 allows for an expenditure of £5.75 million by S.A.A. for the purchase of three jet transports.

* * *

Eastern Air Lines's 1957 profit was $6,843,000, compared with $14,198,000 in 1956. Operating revenues ($262m) were up 15.1 per cent, but operating expenses ($252m) rose 26.2 per cent.

* * *

The Air Registration Board announces the issue of the following Notices to licensed aircraft engineers and to owners of civil aircraft: Contents List, Issue 20; No. 2, Issue 12; No. 4, Issue 22; No. 7, Issue 21.

* * *

The American *Aviation Daily* reports the possibility that Panair do Brasil's four DC-8s will come from the fleet of 25 originally ordered by PanAm. The four DC-8s for Panagra will also come from PanAm's original order, thus leaving the latter with 17 DC-8s.

* * *

Mr. Edgar Stewart Fay, M.A., Q.C., is conducting the public inquiry into the accident of the Aquila Airways Solent G-AKNU near Newport, Isle of Wight, on November 15 last. Captain R. I. B. Winn of B.O.A.C., and Mr. S. L. Bolton, a B.O.A.C. engineer officer, are the Assessors. The inquiry opened on February 18 at Holborn Town Hall, London.

A new runway is to be built at Lydda airport, Tel-Aviv, at a cost of about £1.6m.

* * *

Southwest Airways have obtained C.A.B. approval to change their name to Pacific Air Lines.

* * *

Air-India plan to introduce a freight service between London and Bombay early this summer.

* * *

Cruzeiro do Sul has been granted a $2.1m Export-Import Bank loan to finance its purchase of four Convair 440s. Eximbank credits for aircraft purchases now amount to $58.6m.

* * *

The Irish Department of Industry and Commerce has stated that survey work on the extensions at Shannon has already begun; it is hoped to complete work by the end of 1959.

* * *

Mr. Bo Bjorkman, Secretary-General of the Air Research Bureau, has resigned to take up a university appointment in Sweden in July. No successor has yet been named.

* * *

During its first full month of flying the first Lockheed Electra flew about 70hr in the course of 42 flights. A level speed of 460 m.p.h. has been achieved; the c.g. was reported to be within 0.7in of prediction; full weight (113,000 lb) take-offs had been achieved; and most take-offs and landings had been achieved in less than 1,900ft without reversing or braking.

* * *

The prototype Lockheed Jetstar (two Bristol Orpheus) has now flown more than 100 hours. Single-engine take-offs and climbs to 20,000ft (from Edwards Air Force Base) have been made; a range of 1,725 st miles has been achieved with "ample fuel reserves" remaining; and speeds of 600 m.p.h. have been exceeded. Mr. Kelly Johnson, Lockheed's vice president engineering and research, has disclosed that tests with external fuel tanks will soon be made.

The Control of Air Traffic

A. Cdre. Mann's Brancker Memorial Lecture to the Institute of Transport

A. Cdre. W. E. G. Mann, C.B., C.B.E., D.F.C., who is remembered as a pioneer of inverted formation aerobatics in the inter-war years, held a succession of responsible signals posts during the war. He went over to duties in civil aviation in 1945, and is now Director-General of Navigational Services, M.T.C.A.

LAST week we briefly summarized the 15th Brancker Memorial Lecture delivered at the Institute of Transport in London on February 10. The origins, development and future requirements of Air Traffic Control, as set out by the lecturer, A. Cdre. Mann, are here summarized more fully in the form of selected quotations.

"RECORDS show that [by 1933] the Air Traffic Control Service at Croydon was earning a high reputation . . . Approximately 11,000 aircraft were contacted and, more important still, over 1,000 position fixes and 6,400 bearings were passed. It is of interest that in 1957 some 300,000 aircraft, flying over the same area, passed over 800,000 position reports by radio-telephony."

"A committee set up in 1935 under the chairmanship of Sir Henry Maybury, to consider the development of civil aviation in the United Kingdom, looked into the difficulties the air traffic control service was experiencing in maintaining safety . . . The Maybury committee recommended that a comprehensive air traffic control organization and all radio facilities should be provided, maintained and operated by the Government. It also envisaged that in the course of time it would be possible for the burden [of considerable cost] to be transferred to aviation itself . . . The question of who should ultimately bear the cost has not yet been resolved . . . The International Civil Aviation Organization is to discuss this problem later in the year."

Development

"The tremendous advances in the development of communications systems and navigational aids during the war were to prove of great significance to the rapid development of post-war transport . . . Radio-telephone communications of very high frequency at last made possible clear and direct speech between captains and controllers. This was a great step forward."

"A G.C.A. ground control approach equipment . . . was introduced at London Airport during 1947 . . . The potentialities of longer-range radar for general surveillance were also appreciated and an experimental service, probably one of the first to be used solely for civil aviation, was introduced in January 1948, using Microwave Early Warning Radar war-time equipment."

"With American experience as a guide a network of national airways was introduced in August 1950, and later extended throughout Western Europe."

"The high speeds of modern aircraft do not give a pilot sufficient time to take adequate avoiding action . . . Therefore we shall have to control the movements of all high-speed aircraft all the time as well as other aircraft when traffic density reaches a certain figure."

"A controller is most efficient when he is busy, but in the interests of safety he must not be fully extended for more than very short periods. The exercise of air traffic control from a Flight Progress Board is a most exacting task, and with exceptionally heavy traffic efficiency can fall off rapidly. This display system no longer meets requirements . . . too much information has to be carried in the controller's head. Therefore a greatly improved method of displaying the traffic situation and its movement in three dimensions is most urgently required."

"Radar serves us well so long as its main function is simply one of confirming to the controller that all aircraft at the same height are safely separated by at least five miles. What the radar controller cannot do as a rule is accept responsibility for maintaining these reduced distances, and also for guiding and virtually navigating individual aircraft *en route*."

"Air traffic control has to use enormous separation standards [over the North Atlantic] due to the very low standards of navigational accuracy possible and to difficult radio communication conditions. In this area the controller has to provide a longitudinal separation of 30 minutes flying time and a lateral separation of 120 nautical miles . . . Many captains now wish to fly along similar tracks at similar heights. Moreover, most flights are scheduled to leave at about the same time. This canalizing of traffic, together with these separation standards, either delays departures or forces aircraft to fly at low uneconomical heights on too many occasions."

The Future

"To illustrate the impact of jet aircraft and the difficulties that confront air traffic control, let us consider the kind of flight plan the operator and captain would like to file. We will assume the flight is from Central Europe to America. Without doubt the captain would want to follow an optimum economic path in both horizontal and vertical planes, probably passing over other traffic centres while climbing at a rate which cannot be specified precisely, to a height which can only be indicated generally, and through traffic which would not have taken off until after he was airborne. At some point he would wish to start his descent through traffic which departed from termini near his destination several hours after he left the ground in Europe. Although he would not wish to cruise at any fixed height, he would require his flight path to be clear of all other traffic. Today no such flight plan could be given a safe clearance by control, and I doubt if it will ever be possible to do so. I trust that the operators of jet aircraft have taken account of this."

"The requirements of turbo-propeller aircraft, fortunately, are somewhat more flexible, but the question that must be faced is: can regular safe and economic operations be carried out by aircraft with such rigid operating requirements, or should the designers of aircraft and engines be asked to provide aircraft with more flexible operating characteristics?"

"Because of the advantages of radar, I think the best solution would be to construct four long-range stations which with aerodrome radars should give cover . . . over the controlled air space in the United Kingdom, from a height of 5,000ft to at least 30,000ft. An essential development would be the introduction of secondary radar . . . with transponder beacons in aircraft."

"Clearly . . . horizonal separations must be considerably reduced . . . aircraft must therefore be navigated much more accurately. For this reason, the United Kingdom, with the support of British European Airways, has consistently advocated for many years the international adoption of the British Decca Navigator System in high traffic density areas."

"The United Kingdom . . . has also undertaken the testing and evaluation of a ground-based long-range system known as Dectra. A number of Atlantic operators will soon be carrying and testing Dectra equipment . . . Early tests . . . hold out hope of an accuracy of five miles in mid-Atlantic."

"The Doppler system would be complementary . . . and would be of the greatest value . . . in areas where traffic is light and where ground-based aids cannot be made available."

"The form and type of data to be transmitted over the world's aeronautical communication systems must soon be standardized if full advantage is to be taken of the possibilities of electronic memory devices and computers."

"With the varying speeds of aircraft and the fact that two succeeding aircraft may be coming from different stacks, the approach radar controller is given the formidable task of positioning aircraft correctly in time and space for the final approach to the runway. Thus, apart from the need for more accurate navigation, it would be most helpful if all aircraft could fly at a common approach speed. Unfortunately, it is probable that the wing tip vortices of certain new aircraft about to be introduced will set up turbulence which may persist for some time in calm air to an extent that separations would have to be increased and therefore the landing rate correspondingly reduced."

"If airports are to be economically operated to their maximum capacity the design of aircraft should permit them to conform to a reasonable range of approach speeds . . . Our aim should be 60 landings per runway per hour in fair weather, and at least 40 in bad weather. It seems to me [that such factors] are not always taken fully into account by the designers and operators of transport aircraft."

"Automatic blind landings are possible today but it will be many years before they will be reliable enough for air transport work."

"I doubt whether heavy STOL and VTOL aircraft could be accepted at an airport without reducing the movement rate of more conventional aircraft. I have some misgivings at the approach speeds of 150 kt or more of some of the jet aircraft soon coming into service . . . Is there not a happy mean between an approach . . . of zero knots [VTOL] and one of 160 knots? If aircraft could approach at a common speed of the order of 80 to 100 knots higher landing rates and increased airport capacities could be safely achieved. Both airports and transport aircraft could then be operated more economically."

Left, a Caudron C.800 of the Aircent Gliding Club. Below, AAFCE members of the club include Air Marshal Sir Theodore McEvoy (seated); Major W. Biereye, German Air Force; Major E. de Bourbel, W.R.A.C.; Capt. H. N. C. Lardennois, French Air Force; Major H. Smith, U.S.A.F.; and Corporal J. Dortmund, Royal Netherlands Air Force.

CLUB AND GLIDING NEWS

SPEAKING at the annual dinner of Imperial College Gliding Club in London on February 7, Cdr. Nicholas Goodhart, R.N., one of the pilots chosen to represent Britain at this year's World Gliding Championships, contrasted British and Polish approaches to competitive gliding. While the Polish team and reserves were reported (*Flight*, January 31) to have entered full-time training on January 16, the British team was still not certain of the aircraft they would fly—and, indeed, the speaker's own ground-crew was not yet complete. Improved new sailplanes were under construction, however, and things would doubtless be all right in the end, provided advance research could establish how to cope with Poland's secret weapon—vodka.

Cdr. Goodhart was replying to the toast of the guests, which had been proposed by John Gibbons, secretary of the club. Among other guests present were Dr. R. P. Linstead, rector of Imperial College; sailplane designer F. N. Slingsby; and Hugo Trotter, chairman of the Surrey Gliding Club. Proposing the health of the I. C. Club, Mr. Trotter said that it was approaching its 28th anniversary, and went on to quote from the commendable rules laid down for the club's first gliding expedition in 1930. The captain of the club, Philip Standeven, replied.

AN extension of membership to include social members has been proposed at Cheltenham Aero Club, Staverton, where a rebuilding programme has made this expansion possible. A new block, housing Link trainer, lecture rooms, stores and sleeping accommodation, is to be erected behind the existing club buildings; and the bar and lounge have already been rebuilt and redecorated by club members. Current hourly flying rates at Staverton are £3 5s (Autocrat), £4 4s (Aiglet Trainer) and £4 10s (Messenger). The aircraft are now serviced by the club's own engineer, Ron Taylor, and schemes are being considered for improving utilization and reducing costs.

It has been felt for some time that an instructors' handbook (on the lines of A.P. 3225 but intended for civil training) is a much-needed item, and Mr. Aubrey Reeves, the club secretary and chief instructor, is now preparing such a book, following full consultation with C.F.S.

THE Aeromere company in the Trento region of Italy is to build both the Falco two-seater and the Airone light twin, presumably under a licence agreement. The Airone will be a new version powered by 150 h.p. engines instead of 105 h.p. Walters. At a later date the company may also manufacture light helicopters.

AFTER a brief winter break, the Aircent Gliding Club, whose members come from the staff of AAFCE headquarters at Fontainebleau, is preparing to resume its flying activities. Formed in June last year, the club first operated from Vimory Airfield, and is now moving to Moret, where it will use the airstrip and hangars of the Aero Club de la Vallee du Loing "Georges Villette." Almost 1,000 launches (572 by aero-tow) were carried out up to the end of 1957, resulting in a total of 425 flying hours. Six of the club's members attended a course in advanced soaring and wave flying at St. Auban, and one achieved his Gold C height there.

Membership includes personnel from the British, Dutch, French, German and U.S. Services, ranging in rank from airman to air marshal. First president of the club's committee was the chief of staff at the headquarters, Air Marshal Sir Theodore McEvoy. Subscriptions are low (the club is assisted financially by the NATO welfare fund), the number of members had to be limited, and a waiting-list established, within a month of the club's inception.

The club's aircraft, loaned by the French Air Force, comprise a Morane-Saulnier M.S. 500 (Fieseler Storch) for towing, a Caudron C.800 two-seater and a single-seater glider. It is hoped to obtain a second single-seater soon.

1958 GLIDING COURSES

GLIDING courses for 1958 announced by the British Gliding Association, and listed here, are intended to give "an introduction to gliding and at the same time an enjoyable outdoor holiday." The prices include flying, instruction, accommodation and food, and all courses (unless otherwise stated) are open to beginners with no gliding experience.

Aberdeen Gliding Club, *Dyce Airfield:* Inquiries to Miss J. Smith, Summerville, Bieldside, Aberdeenshire. Weekly courses, April 6-12 and each week from June 29 to August 23. Price 14 guineas.

Bristol Gliding Club, *Nympsfield, near Stroud, Glos:* Inquiries to course secretary at the club. Weekly courses.

Cornish Gliding Club, *Perranporth:* C. Milner-Haigh, Hawkes Point, Carbis Bay, St. Ives. Weekly courses April 21-25, May 12-16, June 2-6, June 30-July 4, July 14-18, September 8-12 and 22-26, October 6-10. Price 14-16 guineas.

Derbyshire and Lancashire Gliding Club, *Camphill, Great Hucklow, Derbyshire:* R. D. Mills, at the club. Weekly courses, price 14 guineas.

Isle of Wight Gliding Club, *Sandown Airport, I.o.W.:* Course manager, at the club. Weekly courses from March to October.

Kent Gliding Club, *Detling Aerodrome, North Downs:* P. Crabtree, 14 Dallin Road, Bexley Heath, Kent. Weekly courses, in conjunction with the Central Council of Physical Recreation, during April, June and July.

London Gliding Club, *Dunstable, Bedfordshire:* Course secretary at the club. Weekly courses April 28-May 2, May 12-16 and 19-23, June 9-13 and 16-20, June 30-July 4, July 7-11 and 21-25, August 11-15 and 18-22, September 1-5, 8-12 and 22-26, September 29-October 3, October 13-17 and 20-24, November 3-7. Prices £14 to £16 10s.

Midland Gliding Club, *Long Mynd, Church Stretton, Salop:* J. W. G. Harnden, 82 Hugh Road, Smethwick, 41. Weekly courses for "B" and "C" certificate glider pilots, and power pilots, June 2-6 and 23-27, July 7-11 and 21-25, August 11-15 and September 1-5. Prices £10 (members) and £15 (non-members).

Scottish Gliding Union, *Portmoak, Scotlandwell, by Kinross:* Course secretary at the club. Weekly courses April 6-12 and 13-19, June 22-28, July 6-12 and 20-26, August 3-9 and 17-23, August 31-September 6. Price 15 guineas.

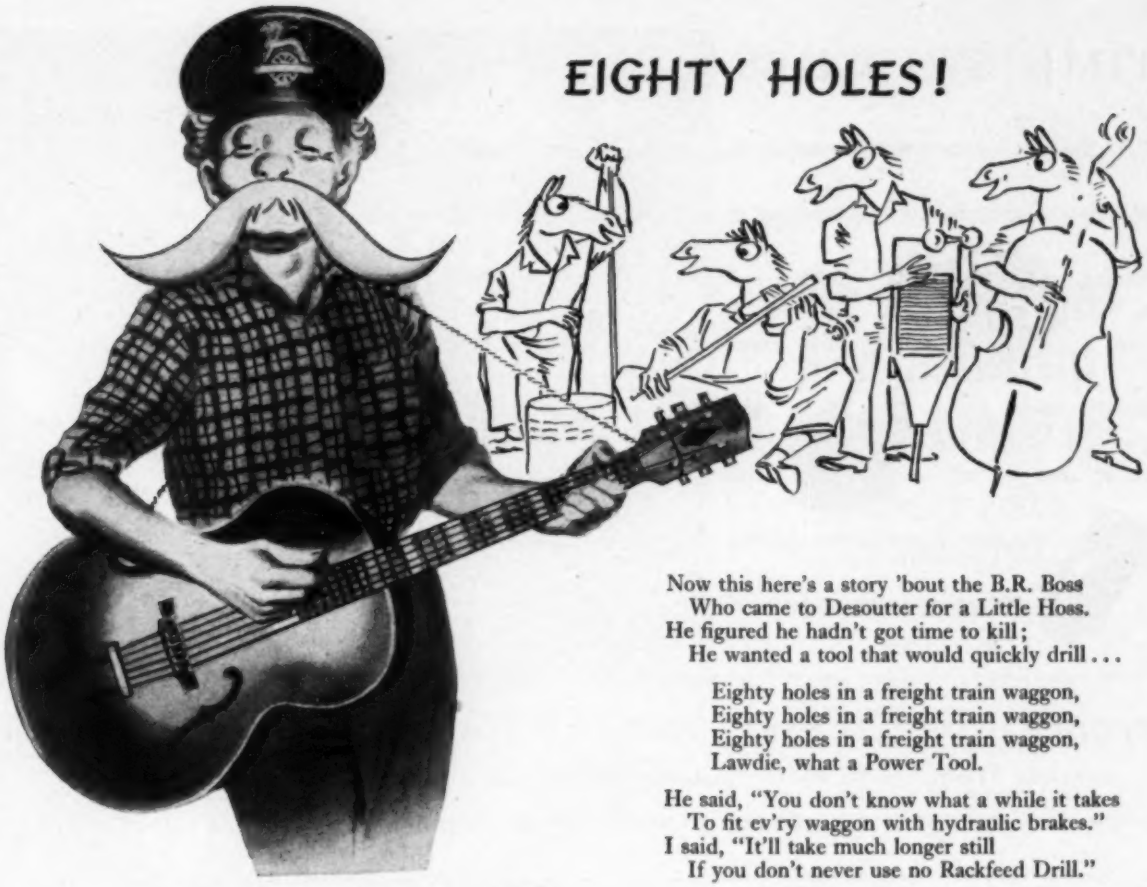
Southdown Gliding Club, *near Firle Beacon, Sussex:* Miss J. Cloke, 34 Graemesdyke Avenue, London, S.W.14. Weekly courses April 8-12, August 5-9 and 24-30. Prices 12-16 guineas.

Surrey Gliding Club, *Lasham Aerodrome:* The manager, Lasham Gliding Centre, Alton, Hants. Weekly courses in each month of the year. Prices 12-16 guineas.

Taunton Vale Gliding Club, *Dunkeswell Aerodrome:* Hon. secretary, Foss End, Stoke Road, North Curry, Somerset. Weekly courses July 27-August 2, August 3-9. Price 15 guineas.

Yorkshire Gliding Club, *Sutton Bank, Yorkshire:* Details from course secretary at the club.

At the Kronfeld Club on February 4 the first of a series of introductory talks on gliding for beginners was given by Wally Kahn on behalf of the British Gliding Association. Illustrated with colour slides and films, similar talks are to be given at 8 p.m. on the first Tuesday of each month until September. The address of the club is 74 (basement) Eccleston Square, London, S.W.1; further details of gliding courses can be obtained from individual clubs listed above or from the B.G.A. at Londonderry House, 19 Park Lane, London, W.1.



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Eighty holes etc.

Now I wasn't gonna lay me down and die,
An' I thought, what the heck, I'll give it a try.
Sure my dentist says it was most unwise,
But I chewed it down to the perfect size.

Eighty holes etc.

Now I reckon I've made it mighty plain,
If our tools ain't right, then we tries again
An' in case you forget, I can only urge
That you sings to yourself this 'orrible dirge . . .

Eighty holes in a freight train waggon,
Eighty holes in a freight train waggon,
Eighty holes in a freight train waggon,
Lawdie, what a Power Tool.

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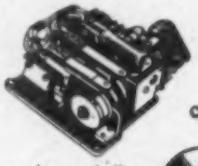
Time Switches—non-resetting, resetting and cycling, are widely used on many of to-day's aircraft for such applications as; gas turbine engine and rocket motor starting  inching mechanisms for power operated flying trim controls, camera gun operation, navigation light flashing units, civil and military; de-icing heater mat cycling units automatic bomb release switches and units designed to provide a fixed duration pulse at selectable intervals.

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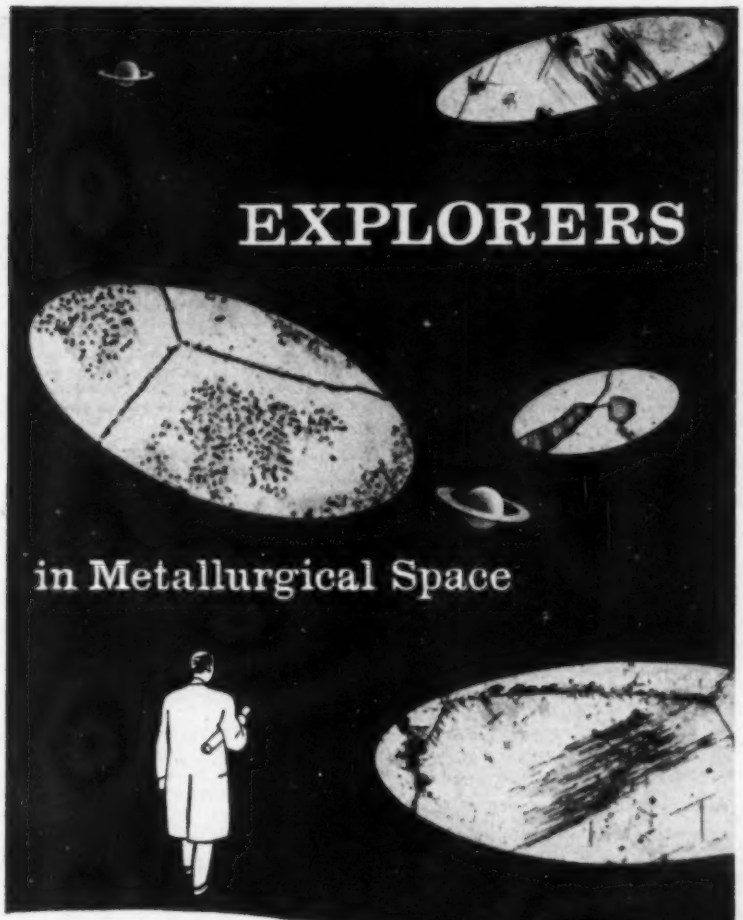

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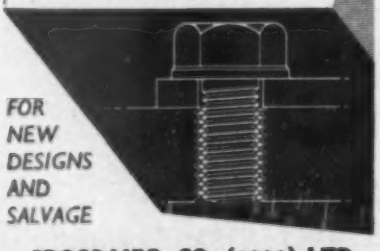

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INDEX TO ADVERTISERS

	Page
Allison Engines	9
Alvis, Ltd.	Facing Edit. Page 246
Armstrong Whitworth Aircraft Co., Ltd., Sir W. G.	10
"Autocar, The,"	37
Birkett, Billington and Newton, Ltd., T. M.	32
Blackburn and General Aircraft, Ltd.	36
Boulton Paul Aircraft, Ltd.	3
B.P. Aviation Service	29
Bristol Aero-Engines, Ltd.	Cover iv
British Air Line Pilots' Association, The	34
British Aluminium Co., Ltd., The	2
British Messier, Ltd.	12
British Thomson-Houston Co., Ltd., The	8
Cross Manufacturing Co. (1938), Ltd.	34, 36
De Havilland Engine Co., Ltd., The	Facing Edit. Page 248
De Havilland Propellers, Ltd.	Facing Edit. Page 239
Delaney Gallay, Ltd.	26
Desoutter Brothers, Ltd.	31
Direct Photographic Supply Co.	35
Dunlop Rubber Co., Ltd.	24, 25
Elliott Brothers (London), Ltd.	6
English Electric Co., Ltd., The	23, 38
Esso Petroleum Co., Ltd.	Facing Edit. Page 232
Fairey Aviation Co., Ltd., The	Facing Edit. Page 238
Firestone Tyre and Rubber Co., Ltd.	4
Firth-Vickers Stainless Steels, Ltd.	5
Goodlin, Chalmers H.	35
Harringay Photo Supplies	35
Helicopter Sales, Ltd.	34
High Duty Alloys, Ltd.	Facing Edit. Page 252
Hunting Aircraft, Ltd.	Facing Edit. Page 247
Iliffe & Sons, Ltd.	37
Jessop and Sons, Ltd., W. M.	7
Kelvin and Hughes (Aviation), Ltd.	Facing Edit. Page 233
Latex Upholstery, Ltd.	38
Lewis, Ltd., D.	34
London School of Air Navigation, Ltd.	36
Lucas (Gas Turbine Equipment), Ltd., Joseph	Cover iii
Marconi's Wireless Telegraph Co., Ltd.	16
Marshall's Flying School, Ltd.	36, 37, 38
Palmer Aero Products, Ltd.	1
Rolls-Royce, Ltd.	11
Shackleton, Ltd., W. S.	34
Shell Aviation Service	Facing Edit. Page 249
Short Brothers and Harland, Ltd.	Cover i
Teddington Aircraft Controls, Ltd.	32
Thorn Electrical Industries, Ltd.	Cover ii
Vickers-Armstrongs (Aircraft), Ltd.	30
Westland Aircraft, Ltd.	15
Wiggin and Co., Ltd., Henry	33, Facing Edit. Page 253

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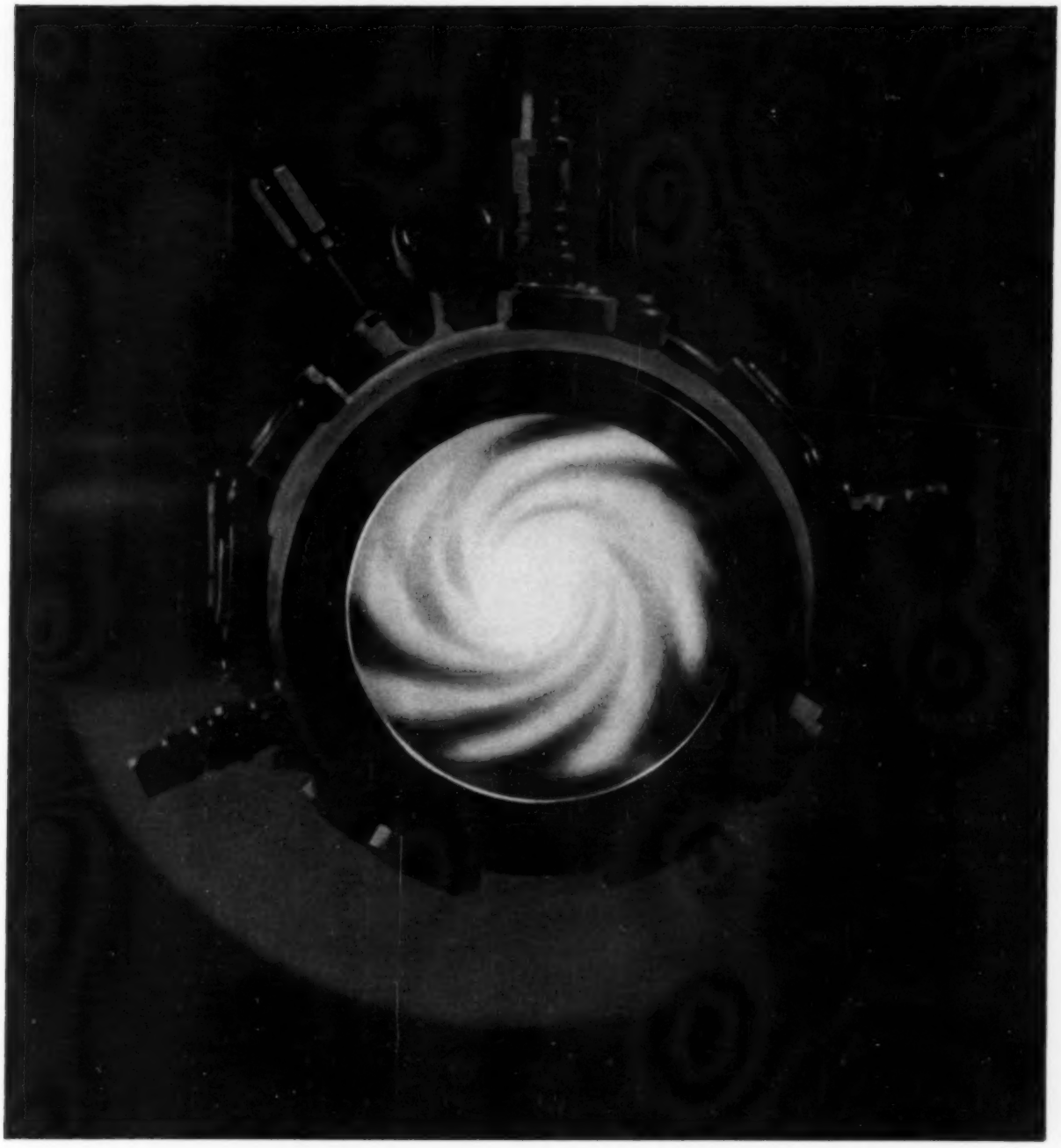
One advertisement in a series of nine



LUCAS PERFORMANCE

THE TEST HALL of the combustion laboratory is equipped to simulate the air pressure, flow and temperature experienced in an aircraft engine combustion chamber.

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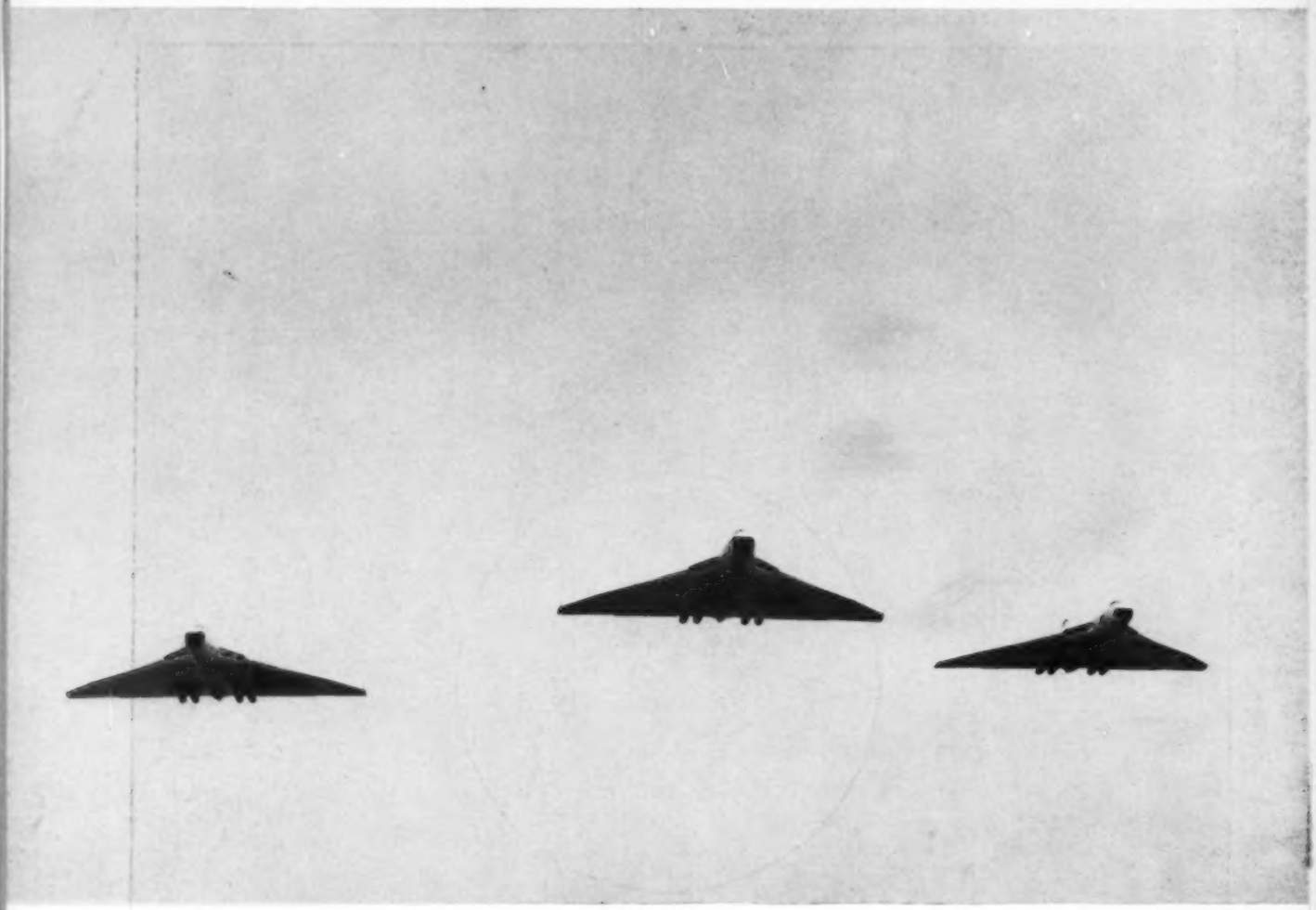

OLYMPUS POWERS THE VULCAN

TWIN-SPOOL OLYMPUS GIVES V BOMBERS GREAT SPEED, HIGH CEILING, LOW FUEL CONSUMPTION

The Avro Vulcan, in squadron service with the Royal Air Force, is powered by Bristol Olympus Mark 100 series turbojets. The Olympus is remarkable for its great power at high altitudes, its very low specific fuel consumption and its exceptional reliability.

The Under Secretary of State for Air, Mr Charles I. Orr-Ewing has stated: "The Vulcan has probably had the minimum amount of teething trouble of any aircraft introduced in the RAF over the last 10 years."

Olympus Mk 200. The Bristol Olympus Mk 200 has been type tested at 16,000 lb thrust—without reheat—and this version, now in production for the Vulcan B Mk II will give the bomber even better performance.

Olympus development. The Olympus is capable of development into the 20,000 lb thrust class. It has already run at observed thrusts of over 17,300 lb without reheat.

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